

Marine Fish and Invertebrate Atlas: Summarizing Geographic Distribution and Population Indices in the Scotian Shelf and Bay of Fundy (1970-2020)

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MARINE FISH AND INVERTEBRATE ATLAS: SUMMARIZING GEOGRAPHIC DISTRIBUTION,
POPULATION INDICES AND ENVIRONMENTAL PREFERENCES IN THE SCOTIAN SHELF
AND BAY OF FUNDY (1970-2020)

by

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CONTENTS

ABSTRACT	ix
RÉSUMÉ	x
1 Introduction	1
2 Methods	2
2.1 Survey Description	2
2.2 Sampling Design	3
2.3 Taxonomic Levels	4
2.4 Analyses	13
2.4.1 Geographic distribution of catches	13
2.4.2 Abundance and biomass indices	13
2.4.3 Distribution indices	13
2.4.4 Length frequencies	13
2.4.5 Length-weight relationship and condition factor	14
2.4.6 Depth, temperature and salinity distribution of catches	14
2.4.7 Density-dependent habitat selection	14
3 Results	15
3.1 Description of Figures	15
3.1.1 Type A	15
3.1.2 Type B	15
3.1.3 Type C.	15
3.1.4 Type D.	16
3.1.5 Type E.	16
3.1.6 Type F.	16
3.2 Summary of successful tows by year and stratum	16

4 Discussion	20
5 Acknowledgements	20
6 References	21
7 Appendix	24
7.1 Atlantic cod (Morue franche) - species code 10 (category LF)	25
7.2 Haddock (Aiglefin) - species code 11 (category LF)	28
7.3 White hake (Merluche blanche) - species code 12 (category LF)	31
7.4 Red hake (Merluche écureuil) - species code 13 (category LF)	34
7.5 Silver hake (Merlu argenté) - species code 14 (category LF)	37
7.6 Pollock (Goberge) - species code 16 (category LF)	40
7.7 Atlantic redfishes (Sébastes de l'Atlantique) - species code 23 (category LF)	43
7.8 Atlantic halibut (Flétan de l'Atlantique) - species code 30 (category LF)	46
7.9 American plaice (Plie canadienne) - species code 40 (category LF)	49
7.10 Witch flounder (Plie grise) - species code 41 (category LF)	52
7.11 Yellowtail flounder (Limande à queue jaune) - species code 42 (category LF)	55
7.12 Winter flounder (Limande-plie rouge) - species code 43 (category LF)	58
7.13 Atlantic wolffish (Loup atlantique) - species code 50 (category LF)	61
7.14 Atlantic herring (Hareng de l'Atlantique) - species code 60 (category LF)	64
7.15 Longhorn sculpin (Chabosseau à dix-huit épines) - species code 300 (category LF)	67
7.16 Moustache sculpin (Faux-trigle armé) - species code 304 (category LF)	70
7.17 Sea raven (Hémithriptère atlantique) - species code 320 (category LF)	73
7.18 Alligatorfish (Poisson-alligator atlantique) - species code 340 (category LF)	76
7.19 Monkfish (Baudroie d'Amérique) - species code 400 (category LF)	79
7.20 Ocean pout (Loquette d'Amérique) - species code 640 (category LF)	82
7.21 Thorny skate (Raie épineuse) - species code 201 (category LF)	85
7.22 Smooth skate (Raie lisse) - species code 202 (category LF)	88

7.23 Winter skate (Raie tachetée) - species code 204 (category LF)	91
7.24 Picked dogfish (Aiguillat commun) - species code 220 (category LF)	94
7.25 Northern shortfin squid (Encornet rouge nordique) - species code 4511 (category LF)	97
7.26 Atlantic hagfish (Myxine du nord) - species code 241 (category LI)	100
7.27 Cusk (Brosme) - species code 15 (category LI)	101
7.28 Greenland halibut (Flétan noir) - species code 31 (category LI)	102
7.29 Gulf Stream flounder (Plie du Gulf Stream) - species code 44 (category LI)	103
7.30 American shad (Alose savoureuse) - species code 61 (category LI)	104
7.31 Alewife (Gaspareau) - species code 62 (category LI)	105
7.32 Capelin (Capelan) - species code 64 (category LI)	106
7.33 Atlantic mackerel (Maquereau commun) - species code 70 (category LI)	107
7.34 Longfin hake (Merluche à longues nageoires) - species code 112 (category LI)	108
7.35 Fourbeard rockling (Motelle à quatre barbillons) - species code 114 (category LI)	109
7.36 Blackbelly rosefish (Sébaste chèvre) - species code 123 (category LI)	110
7.37 Greater argentine (Grande argentine) - species code 160 (category LI)	111
7.38 Arctic hookear sculpin (Hameçon neigeux) - species code 306 (category LI)	112
7.39 Atlantic poacher (Agone atlantique) - species code 350 (category LI)	113
7.40 Marlin-spike grenadier (Grenadier du Grand Banc) - species code 410 (category LI)	114
7.41 Lumpfish (Lompe) - species code 501 (category LI)	115
7.42 Atlantic spiny lumpsucker (Petite poule de mer atlantique) - species code 502 (category LI)	116
7.43 Sand lance (Lançon) - species code 610 (category LI)	117
7.44 Snakeblenny (Lompénie-serpent) - species code 622 (category LI)	118
7.45 Daubed shanny (Lompénie tachetée) - species code 623 (category LI)	119
7.46 Vahl's eelpout (Lycode à carreaux) - species code 647 (category LI)	120
7.47 Atlantic butterfish (Stromaté fossette) - species code 701 (category LI)	121
7.48 Atlantic hookear sculpin (Hameçon atlantique) - species code 880 (category LI)	122

7.49 Barndoor skate (Grande raie) - species code 200 (category LI)	123
7.50 Little skate (Raie hérisson) - species code 203 (category LI)	124
7.51 Northern prawn (Crevette nordique) - species code 2211 (category SF)	125
7.52 Jonah crab (Tourteau jona) - species code 2511 (category SF)	126
7.53 Atlantic rock crab (Tourteau poïnclos) - species code 2513 (category SF)	127
7.54 Arctic lyre crab (Crabe <i>Hyas coarctatus</i>) - species code 2521 (category SF)	128
7.55 Atlantic king crab (Crabe épineux du nord) - species code 2523 (category SF)	129
7.56 Queen crab (Crabe des neiges) - species code 2526 (category SF)	130
7.57 Great spider crab (Crabe lyre araignée) - species code 2527 (category SF)	131
7.58 American lobster (Homard américain) - species code 2550 (category SF)	132
7.59 Sea lamprey (Lamproie marine) - species code 240 (category LR)	133
7.60 Atlantic tomcod (Poulamon atlantique) - species code 17 (category LR)	134
7.61 Offshore silver hake (Merlu argenté du large) - species code 19 (category LR)	135
7.62 Spotted wolffish (Loup tacheté) - species code 51 (category LR)	136
7.63 Northern wolffish (Loup à tête large) - species code 52 (category LR)	137
7.64 Rainbow smelt (Éperlan arc-en-ciel) - species code 63 (category LR)	138
7.65 Cunner (Tanche-tautogue) - species code 122 (category LR)	139
7.66 Fourspot flounder (Cardeau à quatre ocelles) - species code 142 (category LR)	140
7.67 Windowpane flounder (Turbot de sable) - species code 143 (category LR)	141
7.68 Longnose greeneye (Oeil-vert à long nez) - species code 149 (category LR)	142
7.69 Lanternfishes (Poissons-lanternes) - species code 150 (category LR)	143
7.70 Shortnose greeneye (Éperlan du large) - species code 156 (category LR)	144
7.71 Silvery lightfish (Brossé améthyste) - species code 158 (category LR)	145
7.72 Boa dragonfish (Dragon-boa) - species code 159 (category LR)	146
7.73 Shorthorn sculpin (Chabosseau à épines courtes) - species code 301 (category LR)	147
7.74 Grubby (Chabosseau bronzé) - species code 303 (category LR)	148
7.75 Polar sculpin (Cotte polaire) - species code 307 (category LR)	149

7.76 Spatulate sculpin (Icèle spatulée) - species code 314 (category LR)	150
7.77 Arctic alligatorfish (Poisson-alligator arctique) - species code 341 (category LR)	151
7.78 Alligatorfishes (Poissons-alligator) - species code 351 (category LR)	152
7.79 Roughnose grenadier (Grenadier-scie) - species code 412 (category LR)	153
7.80 Roundnose grenadier (Grenadier de roche) - species code 414 (category LR)	154
7.81 Atlantic seasnail (Limace atlantique) - species code 503 (category LR)	155
7.82 Gelatinous snailfish (Limace gélantineuse) - species code 505 (category LR)	156
7.83 Variegated snailfish (Limace marbée) - species code 512 (category LR)	157
7.84 Sea tadpole (Petite limace de mer) - species code 520 (category LR)	158
7.85 Wolf eelpout (Lycode à tête longue) - species code 603 (category LR)	159
7.86 Slender snipe eel (Avocette ruban) - species code 604 (category LR)	160
7.87 Newfoundland eelpout (Lycode du Labrador) - species code 619 (category LR)	161
7.88 Newfoundland eelpout (Lycode du Labrador) - species code 620 (category LR)	162
7.89 Rock gunnel (Sigouine de roche) - species code 621 (category LR)	163
7.90 Radiated shanny (Ulvaire deux-lignes) - species code 625 (category LR)	164
7.91 Fourline snakeblenny (Quatre-lignes atlantique) - species code 626 (category LR)	165
7.92 Wrymouth (Terrassier tacheté) - species code 630 (category LR)	166
7.93 Spotfin dragonet (Dragonnet tacheté) - species code 637 (category LR)	167
7.94 Arctic eelpout (Lycode arctique) - species code 641 (category LR)	168
7.95 Atlantic soft pout (Molasse atlantique) - species code 646 (category LR)	169
7.96 Silvery John dory (Saint Pierre argenté) - species code 704 (category LR)	170
7.97 White barracudina (Lussion blanc) - species code 712 (category LR)	171
7.98 Atlantic saury (Balaou atlantique) - species code 720 (category LR)	172
7.99 Hatchetfishes (Haches d'argent) - species code 741 (category LR)	173
7.100 Atlantic batfish (Malthe atlantique) - species code 742 (category LR)	174
7.101 Spottedfin tonguefish (Langue fil noir) - species code 816 (category LR)	175
7.102 Black dogfish (Aiguillat noir) - species code 221 (category LR)	176

7.103	Longfin inshore squid (Calmar totam) - species code 4512 (category LR)	177
7.104	Red deepsea crab (Crabe rouge) - species code 2532 (category SR)	178

INDEX**179**

ABSTRACT

Ricard, D. and Gomez, C. 2021. Marine Fish and Invertebrate Atlas: Summarizing Geographic Distribution, Population Indices and Environmental Preferences in the Scotian Shelf and Bay of Fundy (1970-2020). Can. Tech. Rep. Fish. Aquat. Sci. nnn: x + 184 p.

The summer groundfish research vessel survey on the Scotian Shelf and in the Bay of Fundy started in 1970 and was designed to measure the distribution and abundance of major commercial fish species. Over time, additional information on non-commercial species was collected, and allowed considerable insight into ecosystem function and structure, as documented in many primary publications whose analyses used the survey data. The same groundfish survey database has also been used to produce species status reports, atlases of species distribution and remains an essential source of information for stock assessments in the Maritimes Region of Fisheries and Oceans Canada. This report builds on previous work and former atlases by updating a comprehensive suite of indices to assess population status and environmental preferences of 104 species. For each species, trends in geographic distribution and biomass or abundance were plotted. The spatial extent of distribution was plotted over time to gauge how the area occupied has changed. The relationship between abundance or biomass and spatial extent reflected whether the species distribution expands when abundance or biomass increases. Length frequencies over time depicted any changes in mean size. The plots of condition over time revealed whether individual fish are fatter or thinner than their long term mean. Depth, temperature and salinity preferences were estimated to gauge the range of suitable environmental parameters for each species. Finally, for each stratum, the slope describing how local density varies with regional abundance was estimated.

RÉSUMÉ

Ricard, D. and Gomez, C. 2021. Marine Fish and Invertebrate Atlas: Summarizing Geographic Distribution, Population Indices and Environmental Preferences in the Scotian Shelf and Bay of Fundy (1970-2020). Can. Tech. Rep. Fish. Aquat. Sci. nnn: x + 184 p.

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1 Introduction

The summer (July-August) groundfish research vessel survey on the Scotian Shelf and in the Bay of Fundy was started in 1970 by Fisheries and Oceans Canada Maritimes Region. The survey was originally designed to measure the distribution and abundance of major commercial fish species. Over time, information on non-commercial species was also collected. The groundfish survey database storing the information collected during the annual survey provides the main source of fisheries-independent information for marine species in the region. This information is routinely used to support stock assessments, to produce species status reports and has been previously used to publish atlases of species distribution.

The current document is an update of an earlier report (Ricard and Shackell 2013) that built on former atlases by updating a comprehensive suite of derived indices for 104 species to assess population status and environmental preferences. The information collected during the survey is stored in a relational database management system archived at Fisheries and Oceans Canada Maritimes Region which contains detailed information about the sampling locations and the associated catch. Tow-level survey data is also publicly available from the Ocean Biogeographic Information System (DFO 2016) and ([FGP link TBA](#)). The present atlas follows on the work done by Fisheries and Oceans colleagues from the northern Gulf of St. Lawrence (Bourdages and Ouellet 2012), southern Gulf of St. Lawrence (Benoît et al. 2003) and on earlier work in the Scotian Shelf (Simon and Comeau 1994; Horsman and Shackell 2009).

To facilitate updates and foster collaboration on the analyses of the survey data, the computer code necessary to extract the data, to perform the analyses presented herein, and to reproduce and update the current document is made available in a git repository (Ricard and Gomez 2021).

The survey area covers three major Northwest Atlantic Fisheries Organization (NAFO) zones that divide the shelf into the colder east 4V and 4W (strata 440-466) and warmer west 4X (strata 470-495). Temporal trends are plotted by NAFO regions for several species. For each species, trends in geographic distribution and biomass or abundance are plotted. Some caution is required in interpreting the results obtained for several taxa due to low sample size as explained later in the text. The spatial extent of distribution is plotted over time to gauge how the area occupied has changed. The relationship between biomass and spatial extent reflects whether the species distribution expands when biomass increases. For each strata, the slope describing how local density varies with regional abundance was estimated (Myers and Stokes 1989). These slopes were then plotted against a habitat suitability index to identify important strata for each species. Then, length frequencies over time depicted any changes in mean size. The plots of condition over time revealed whether individual fish are fatter or thinner than their long term mean. Finally, depth, temperature and salinity preferences were estimated to gauge the range of environmental parameters (Perry and Smith 1994). A full ecological interpretation of trends is beyond the scope of this report. Other documents stemming from peer-reviewed scientific processes under the auspices of the [Canadian Science Advisory Secretariat](#) (CSAS) provide further descriptions of spatio-temporal trends in different indicators and put the information collected during the summer groundfish research vessel survey in a more focused context (see for example Clark and Emberley (2011)).

2 Methods

2.1 Survey Description

The survey is conducted annually in July-August and covers the Scotian Shelf and the Bay of Fundy (Figure 1). It normally involves two separate two-week trips on board an offshore fisheries vessel from the Canadian Coast Guard.

A number of changes in fishing gear type and vessels used occurred since the onset of sampling activities (Clark and Emberley 2011).

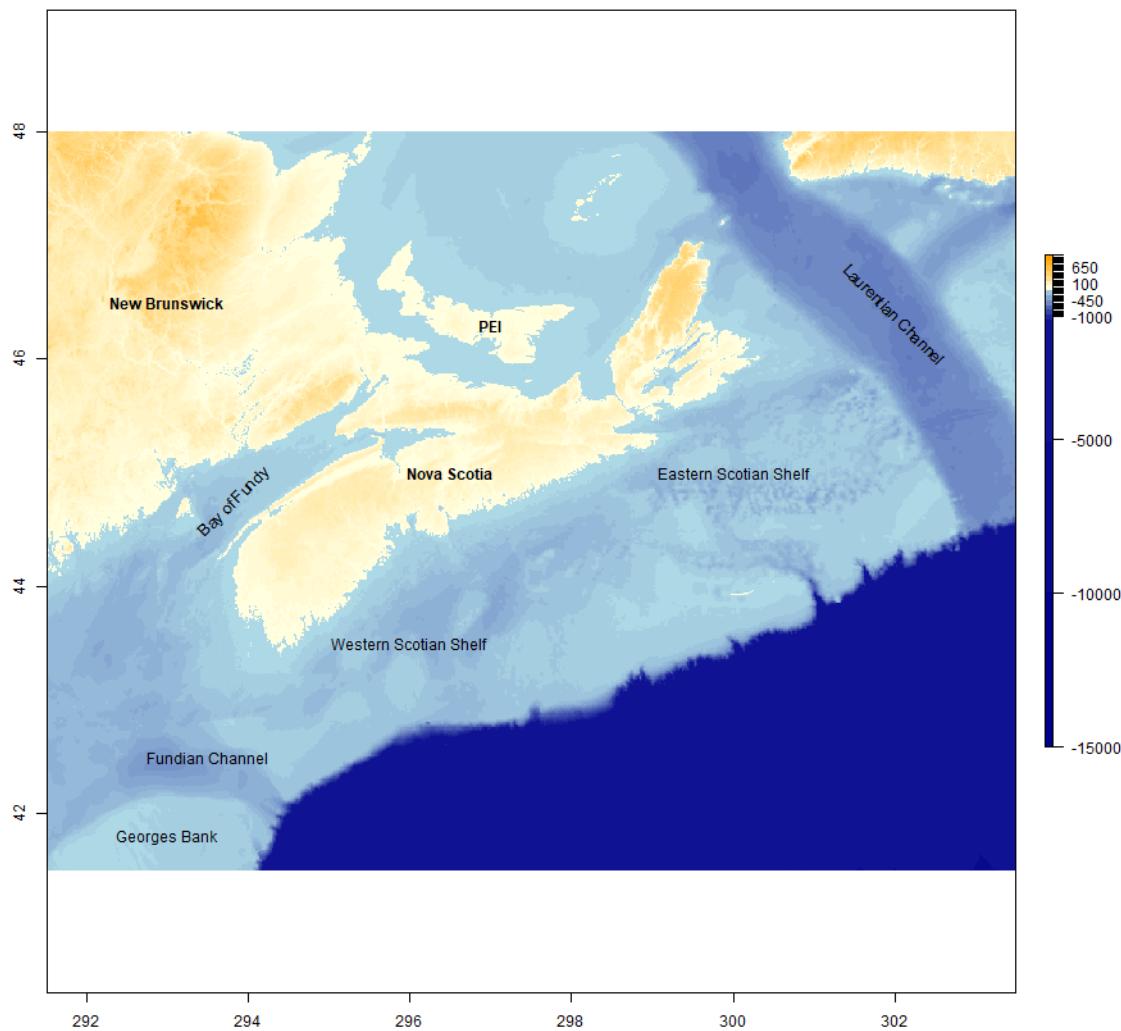


Figure 1. Map of the Scotian Shelf and Bay of Fundy.

2.2 Sampling Design

The summer survey covers divisions 4V, 4W and 4X of the Northwest Atlantic Fisheries Organization (NAFO) which includes the Scotian Shelf and the Bay of Fundy. The eastern limit of the survey is the Laurentian Channel and the western limit is the Fundian Channel (Figure 1).

The survey follows a stratified random design (Doubleday and Rivard 1981; Lohr 1999) (Figure 2). The number of tows conducted in each stratum is approximately proportional to its surface area.

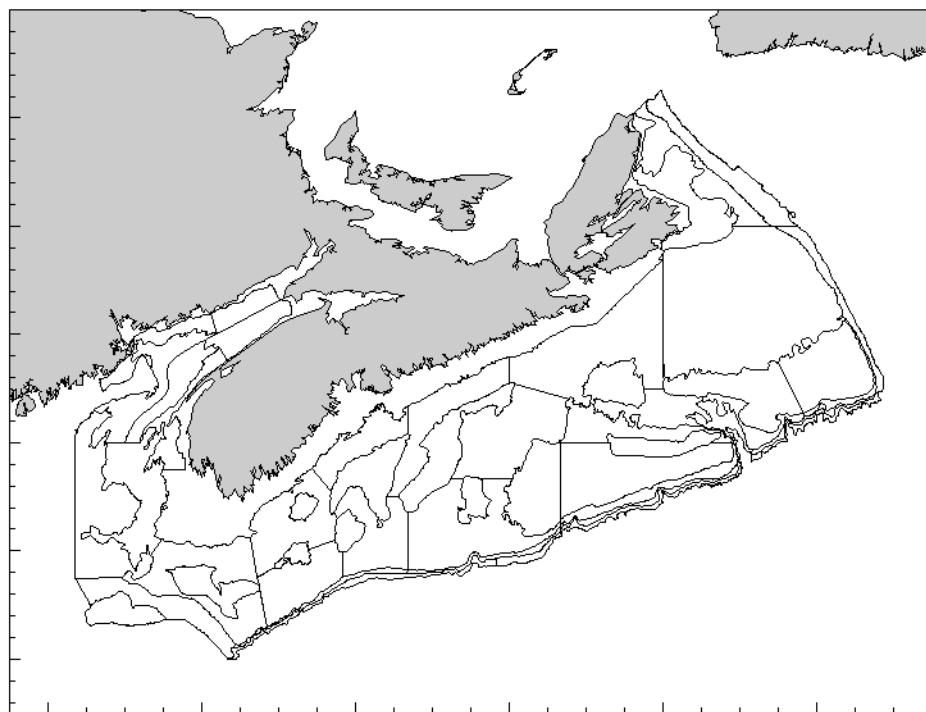


Figure 2. Map of the Summer survey strata.

The basic sampling unit of the survey is a 30-minute fishing tow conducted at a speed of 3.5 knots. This yields a distance towed of 1.75 nautical miles.

After each tow the catch is sorted by species and weighed. Each fish caught is then measured, and further sampling of individual fish weight, maturity status and age are performed for different length classes. When catches exceed 300 individuals, a random sub-sample is used to obtain the length and weight measurements.

The location of representative tows appears in Figure 3.

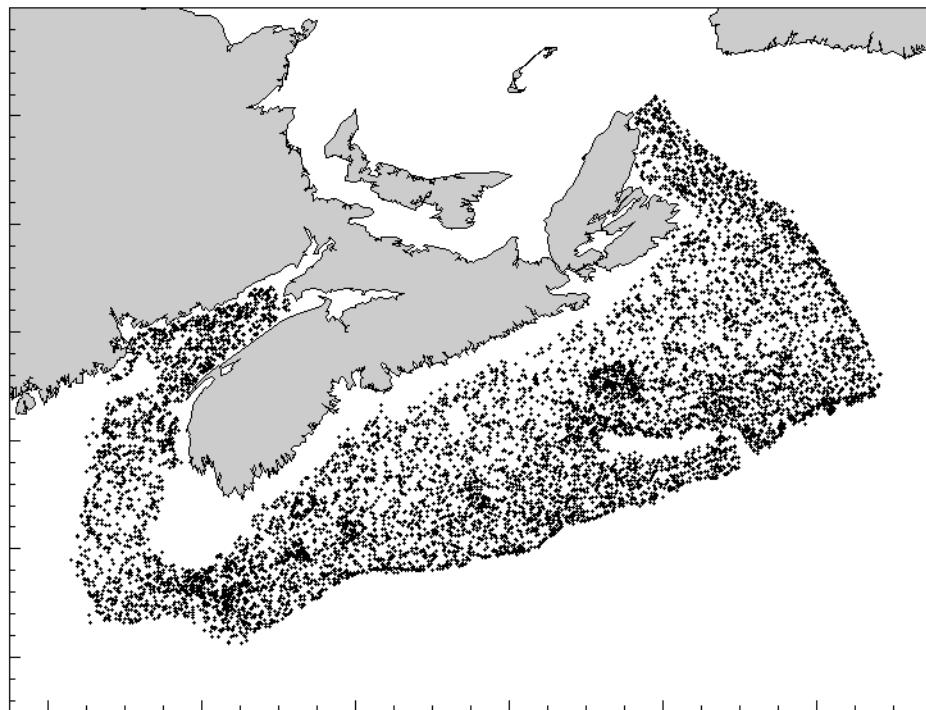


Figure 3. Map of the Summer survey tows.

2.3 Taxonomic Levels

Fish species caught during the surveys are identified by trained scientific personnel and their scientific name is determined. An internal species code used in the relational database is reported for each species (Losier and Waite 1989).

By its nature as a bottom trawl, the fishing gear used in the survey catches certain species better than others. To ensure that meaningful ecological information can be extracted from catch samples, we report the catch records for the subset of species that are caught reliably by the gear. To appear in this atlas, a species must have had a minimum of 10 observations over the duration of the survey activities. While both catch abundance and weight are recorded, the weight of species that appear at low abundances is often recorded as zero in the earlier parts of the survey when scales of appropriate precision were not available.

We divided the species caught into five categories based on 1) their taxonomic classification, 2) the number of recorded observations, and 3) their period of valid identification (Table 1). Category "LF", for "long frequent", was assigned to species that have more than 1000 records since 1970 and have been consistently identified since the onset of the survey. Category "LI", for "long intermediate", was assigned to species that had between 1000 and 200 catch records. Rare and elusive species (those with less than 200 catch records over the duration of the survey) are also reported but to a lower level of analytical details (Category "LR", for "long rare"). Category "SF", for "short frequent", was assigned to invertebrate species that were consistently sampled only since 1999 (Tremblay M. J. 2007). And category "SR", for "short rare" for invertebrate species consistently sampled only since 1999 and with less than 200 catch records. The list of taxa covered in this document is presented in phylogenetic order (Nelson J. S. et al. 2004) in Table 2. To ensure concordance with authoritative taxonomic information, the AphiaID from the World Register of Marine Species is also provided in Table 2 (Appeltans et al. 2012).

Category	Name	Description
L	long - consistently identified since the onset of the survey in 1970	
LF	long frequent	species that have more than 1000 catch records
LI	long intermediate	species that had between 1000 and 200 catch records
LR	long rare	species with less than 200 catch records
S	short - invertebrate species that were consistently sampled only since 1999	
SF	short frequent	species with more than 200 catch records
SR	short rare	species with less than 200 catch records

Table 1. Taxonomic levels

Table 2. List of species included in the Atlas. The species reported here are listed in phylogenetic order as per Page L. M. et al. (2013). For each taxonomic order and class, each species is listed in the table, its taxonomic family and scientific name is provided, along with its French and English common names, the species code used in the survey database, its AphiaID and a link to the World Registry of Marine Species, its number of catch records in the survey database and its classification category as defined in section 2.3.

	Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
Myxini								
<i>Myxiniformes</i>								
	Myxinidae	<i>Myxine glutinosa</i>	Atlantic hagfish	Myxine du nord	241	101170	804	LI
Petromyzonti								
<i>Petromyzontiformes</i>								
	Petromyzontidae	<i>Petromyzon marinus</i>	Sea lamprey	Lamproie marine	240	101174	16	LR
Actinopterygii								
<i>Gadiformes</i>								
♂	Gadidae	<i>Gadus morhua</i>	Atlantic cod	Morue franche	10	126436	5451	LF
		<i>Melanogrammus aeglefinus</i>	Haddock	Aiglefin	11	126437	5827	LF
	Phycidae	<i>Urophycis tenuis</i>	White hake	Merluche blanche	12	126504	3524	LF
		<i>Urophycis chuss</i>	Red hake	Merluche écureuil	13	126503	2195	LF
	Merlucciidae	<i>Merluccius bilinearis</i>	Silver hake	Merlu argenté	14	158962	4936	LF
	Lotidae	<i>Brosme brosme</i>	Cusk	Brosme	15	126447	688	LI
	Gadidae	<i>Pollachius virens</i>	Pollock	Goberge	16	126441	2787	LF
		<i>Microgadus tomcod</i>	Atlantic tomcod	Poulamon atlantique	17	158928	44	LR
	Merlucciidae	<i>Merluccius albidus</i>	Offshore silver hake	Merlu argenté du large	19	158748	161	LR
<i>Scorpaeniformes</i>								
	Sebastidae	<i>Sebastes</i>	Atlantic redfishes	Sébastes de l'Atlantique	23	126175	4152	LF
<i>Pleuronectiformes</i>								
	Pleuronectidae	<i>Hippoglossus hippoglossus</i>	Atlantic halibut	Flétan de l'Atlantique	30	127138	1634	LF

Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
Pleuronectidae	<i>Reinhardtius hippoglossoides</i>	Greenland halibut	Flétan noir	31	127144	736	LI
	<i>Hippoglossoides platessoides</i>	American plaice	Plie canadienne	40	127137	6023	LF
	<i>Glyptocephalus cynoglossus</i>	Witch flounder	Plie grise	41	127136	4301	LF
	<i>Limanda ferruginea</i>	Yellowtail flounder	Limande à queue jaune	42	158879	3233	LF
	<i>Pseudopleuronectes americanus</i>	Winter flounder	Limande-plie rouge	43	158885	1632	LF
Paralichthyidae	<i>Citharichthys arctifrons</i>	Gulf Stream flounder	Plie du Gulf Stream	44	158791	382	LI
<i>Perciformes</i>							
Anarhichadidae	<i>Anarhichas lupus</i>	Atlantic wolffish	Loup atlantique	50	126758	1572	LF
	<i>Anarhichas minor</i>	Spotted wolffish	Loup tacheté	51	126759	20	LR
	<i>Anarhichas denticulatus</i>	Northern wolffish	Loup à tête large	52	126757	17	LR
<i>Clupeiformes</i>							
Clupeidae	<i>Clupea harengus</i>	Atlantic herring	Hareng de l'Atlantique	60	126417	3487	LF
	<i>Alosa sapidissima</i>	American shad	Alose savoureuse	61	158670	468	LI
	<i>Alosa pseudoharengus</i>	Alewife	Gaspareau	62	158669	977	LI
<i>Osmeriformes</i>							
Osmeridae	<i>Osmerus mordax</i>	Rainbow smelt	Éperlan arc-en-ciel	63	126737	59	LR
	<i>Mallotus villosus</i>	Capelin	Capelan	64	126735	540	LI
<i>Perciformes</i>							
Scombridae	<i>Scomber scombrus</i>	Atlantic mackerel	Maquereau commun	70	127023	696	LI
<i>Gadiformes</i>							

	Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category	
	Phycidae	<i>Phycis chesteri</i>	Longfin hake	Merluche à longues nageoires	112	158988	784	LI	
	Lotidae	<i>Enchelyopus cimbricus</i>	Fourbeard rockling	Motelle à quatre barbillons	114	126450	693	LI	
<i>Perciformes</i>	Labridae	<i>Tautogolabrus adspersus</i>	Cunner	Tanche-tautogue	122	159785	82	LR	
	Sebastidae	<i>Helicolenus dactylopterus</i>	Blackbelly rosefish	Sébaste chèvre	123	127251	610	LI	
∞	<i>Pleuronectiformes</i>	Paralichthyidae	<i>Hippoglossina oblonga</i>	Fourspot flounder	Cardeau à quatre ocelles	142	158833	76	LR
		Scophthalmidae	<i>Scophthalmus aquosus</i>	Windowpane flounder	Turbot de sable	143	158907	115	LR
	<i>Aulopiformes</i>	Chlorophthalmidae	<i>Parasudis truculenta</i>	Longnose greeneye	Oeil-vert à long nez	149	158868	45	LR
		Myctophidae	<i>Myctophidae</i>	Lanternfishes	Poissons-lanternes	150	125498	160	LR
	<i>Aulopiformes</i>	Chlorophthalmidae	<i>Chlorophthalmus agassizi</i>	Shortnose greeneye	Éperlan du large	156	126336	78	LR
		Sternopychidae	<i>Maurolicus muelleri</i>	Silvery lightfish	Brossé améthyste	158	127312	52	LR
	Stomiidae	<i>Stomias boa</i>	Boa dragonfish	Dragon-boa	159	127374	20	LR	
<i>Argentiniformes</i>	Argentinidae	<i>Argentina silus</i>	Greater argentine	Grande argentine	160	126715	963	LI	
	<i>Scorpaeniformes</i>	Cottidae	<i>Myoxocephalus octodecemspinosus</i>	Longhorn sculpin	Chabosseau à dix-huit épines	300	159520	3292	LF

Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
	<i>Myoxocephalus scorpius</i>	Shorthorn sculpin	Chabosseau à épines courtes	301	127203	131	LR
	<i>Myoxocephalus aenaeus</i>	Grubby	Chabosseau bronzé	303	159519	40	LR
	<i>Triglops murrayi</i>	Moustache sculpin	Faux-trigle armé	304	127205	1182	LF
	<i>Arctediellus uncinatus</i>	Arctic hookear sculpin	Hameçon neigeux	306	127195	306	LI
Psychrolutidae	<i>Cottunculus microps</i>	Polar sculpin	Cotte polaire	307	127235	29	LR
Cottidae	<i>Icelus spatula</i>	Spatulate sculpin	Icele spatulée	314	127200	40	LR
Hemitripteridae	<i>Hemitripterus americanus</i>	Sea raven	Hémithriptère atlantique	320	159518	2126	LF
Agonidae	<i>Aspidophoroides monopterygius</i>	Alligatorfish	Poisson-alligator atlantique	340	159459	1029	LF
	<i>Ulcina olrikii</i>	Arctic alligatorfish	Poisson-alligator arctique	341	274356	13	LR
	<i>Leptagonus decagonus</i>	Atlantic poacher	Agone atlantique	350	127191	266	LI
	<i>Agonidae</i>	Alligatorfishes	Poissons-alligator	351	125588	43	LR
<i>Lophiiformes</i>							
Lophiidae	<i>Lophius americanus</i>	Monkfish	Baudroie d'Amérique	400	159184	1970	LF
<i>Gadiformes</i>							
Macrouridae	<i>Nezumia bairdii</i>	Marlin-spike grenadier	Grenadier du Grand Banc	410	183289	529	LI
	<i>Trachyrincus murrayi</i>	Roughnose grenadier	Grenadier-scie	412	126481	18	LR
	<i>Coryphaenoides rupestris</i>	Roundnose grenadier	Grenadier de roche	414	158960	17	LR
<i>Scorpaeniformes</i>							
Cyclopteridae	<i>Cyclopterus lumpus</i>	Lumpfish	Lompe	501	127214	216	LI

Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
	<i>Eumicrotremus spinosus</i>	Atlantic spiny lump sucker	Petite poule de mer atlantique	502	127217	226	LI
Liparidae	<i>Liparis atlanticus</i>	Atlantic seasnail	Limace atlantique	503	159524	34	LR
	<i>Liparis fabricii</i>	Gelatinous snailfish	Limace gélatineuse	505	127218	27	LR
	<i>Liparis gibbus</i>	Variegated snailfish	Limace marbée	512	159526	41	LR
	<i>Careproctus reinhardtii</i>	Sea tadpole	Petite limace de mer	520	127212	18	LR
<i>Perciformes</i>							
Zoarcidae	<i>Lycenchelys verrillii</i>	Wolf eelpout	Lycode à tête longue	603	159258	40	LR
<i>Anguilliformes</i>							
Nemichthyidae	<i>Nemichthys scolopaceus</i>	Slender snipe eel	Avocette ruban	604	126306	28	LR
<i>Perciformes</i>							
Ammodytidae	<i>Ammodytes dubius</i>	Sand lance	Lançon	610	151520	1283	LI
Zoarcidae	<i>Lycodes terraenovae</i>	Newfoundland eelpout	Lycode du Labrador	619	127117	64	LR
	<i>Lycodes lavalaei</i>	Newfoundland eelpout	Lycode du Labrador	620	127107	72	LR
Pholidae	<i>Pholis gunnellus</i>	Rock gunnel	Sigouine de roche	621	126996	21	LR
Stichaeidae	<i>Lumpenus lampretaeformis</i>	Snakeblenny	Lompénie-serpent	622	154675	423	LI
	<i>Leptoclinus maculatus</i>	Daubed shanny	Lompénie tachetée	623	127072	443	LI
	<i>Ulvaria subbifurcata</i>	Radiated shanny	Ulvaire deux-lignes	625	159821	145	LR
	<i>Eumesogrammus praecisus</i>	Fourline snakeblenny	Quatre-lignes atlantique	626	159817	40	LR
Cryptacanthodidae	<i>Cryptacanthodes maculatus</i>	Wrymouth	Terrassier tacheté	630	159675	120	LR
Callionymidae	<i>Foetorepus agassizii</i>	Spotfin dragonet	Dragonnet tacheté	637	276339	20	LR

Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category	
Zoarcidae	<i>Zoarces americanus</i>	Ocean pout	Loquette d'Amérique	640	159267	1478	LF	
	<i>Lycodes reticulatus</i>	Arctic eelpout	Lycode arctique	641	127112	70	LR	
	<i>Melanostigma atlanticum</i>	Atlantic soft pout	Molasse atlantique	646	127120	43	LR	
	<i>Lycodes vahlii</i>	Vahl's eelpout	Lycode à carreaux	647	127118	565	LI	
Stromateidae	<i>Peprilus triacanthus</i>	Atlantic butterfish	Stromaté fossette	701	159828	487	LI	
Zeiformes	Zeidae	<i>Zenopsis conchifer</i>	Silvery John dory	Saint Pierre argenté	704	127426	39	LR
Aulopiformes	Paralepididae	<i>Arctozenus risso</i>	White barracudina	Lussion blanc	712	126352	196	LR
Beloniformes	Scomberesocidae	<i>Scomberesox saurus</i>	Atlantic saury	Balaou atlantique	720	126392	37	LR
Stomiiformes	Sternopychidae	<i>Sternopychidae</i>	Hatchetfishes	Haches d'argent	741	125603	21	LR
Lophiiformes	Ogcocephalidae	<i>Dibranchus atlanticus</i>	Atlantic batfish	Malthe atlantique	742	126558	18	LR
Pleuronectiformes	Cynoglossidae	<i>Symphurus diomedeanus</i>	Spottedfin tonguefish	Langue fil noir	816	159358	24	LR
Scorpaeniformes	Cottidae	<i>Artediellus atlanticus</i>	Atlantic hookear sculpin	Hameçon atlantique	880	127193	258	LI
Elasmobranchii								
Rajiformes	Rajidae	<i>Dipturus laevis</i>	Barndoor skate	Grande raie	200	158548	246	LI
		<i>Amblyraja radiata</i>	Thorny skate	Raie épineuse	201	105865	3937	LF
		<i>Malacoraja senta</i>	Smooth skate	Raie lisse	202	158554	1773	LF

Family	Scientific name	English name	French name	Species code	AphiaID	Num. records	Category
<i>Squaliformes</i>	<i>Leucoraja erinacea</i>	Little skate	Raie hérisson	203	158551	712	LI
	<i>Leucoraja ocellata</i>	Winter skate	Raie tachetée	204	158553	1180	LF
<i>Squalidae</i>	<i>Squalus acanthias</i>	Picked dogfish	Aiguillat commun	220	105923	1985	LF
	<i>Centroscyllium fabricii</i>	Black dogfish	Aiguillat noir	221	105906	31	LR
Cephalopoda							
<i>Oegopsida</i>							
Ommastrephidae	<i>Illex illecebrosus</i>	Northern shortfin squid	Encornet rouge nordique	4511	153087	4836	LF
<i>Myopsida</i>							
Loliginidae	<i>Doryteuthis pealeii</i>	Longfin inshore squid	Calmar totam	4512	574541	96	LR
Malacostraca							
<i>Decapoda</i>							
Pandalidae	<i>Pandalus borealis</i>	Northern prawn	Crevette nordique	2211	107649	718	SF
Cancridae	<i>Cancer borealis</i>	Jonah crab	Tourteau jona	2511	158056	1387	SF
	<i>Cancer irroratus</i>	Atlantic rock crab	Tourteau poïnclos	2513	158057	788	SF
Oregoniidae	<i>Hyas coarctatus</i>	Arctic lyre crab	Crabe Hyas coarctatus	2521	107323	711	SF
Lithodidae	<i>Lithodes maja</i>	Atlantic king crab	Crabe épineux du nord	2523	107205	531	SF
Oregoniidae	<i>Chionoecetes opilio</i>	Queen crab	Crabe des neiges	2526	107315	1546	SF
	<i>Hyas araneus</i>	Great spider crab	Crabe lyre araignée	2527	107322	625	SF
Geryonidae	<i>Chaceon quinquedens</i>	Red deepsea crab	Crabe rouge	2532	158407	33	SR
Nephropidae	<i>Homarus americanus</i>	American lobster	Homard américain	2550	156134	1623	SF

2.4 Analyses

The Oracle relational database where all data are stored was accessible from the Bedford Institute of Oceanography in Dartmouth, Nova Scotia. Structured Query Language (SQL) is used to extract the data from the production server and to create the data products used in all subsequent analyses. Catch records classified as "valid" (i.e. a representative tow without damage to the net) are used in the current analyses. To make the available samples comparable, catch number and weight for each species was standardized for the distance towed.

All data processing and analyses were conducted using the R software (R Core Team 2020) using packages gstat (Pebesma 2004), PBSmapping (Schnute et al. 2019), RODBC (Ripley and Lapsley 2019), spatstat (Baddeley 2015), maptools (Bivand and Lewin-Koh 2020), rgeos (Bivand and Rundel 2020), classInt(Bivand 2020), RColorBrewer(Neuwirth 2014), MASS (Ripley et al. 2020), worms (Holstein 2018), and tidyverse (Wickham 2019). The present document is rendered as a Technical Report using the csasdown R package developed and maintained by Fisheries and Oceans Canada scientists (Anderson et al. In press).

2.4.1 Geographic distribution of catches

Spatial interpolation of catch biomass (kg/tow) or abundance (number/tow) was done using a weighting inversely proportional to the distance, using function "idw" of the spatstat R package (Baddeley 2015).

2.4.2 Abundance and biomass indices

For each species, stratified random estimates of catch abundance and biomass (Smith 1996) were computed for each year. Yearly estimates of the standard error were also computed.

2.4.3 Distribution indices

For each Category L, I and S fish species, the minimum area required to account for 75% and 95% of the total biomass or abundance were computed (D75% and D95%). These measures of distributions were computed for each year by using the Lorenz curve of mean stratum-level catch estimates and the area of occupied strata (Swain and Sinclair 1994; Swain and Morin 1996).

2.4.4 Length frequencies

The length frequency distribution of catch is tabulated for each seven-year period (1970-2009), and last ten-year period (2010-2020).

2.4.5 Length-weight relationship and condition factor

The relationship between the weight and the length of fish was estimated using the following non-linear isometric relationship:

$$W = \alpha L^\beta$$

where W is the total weight (g), L is the length (cm), and, α and β are the parameters to be estimated.

Average fish condition (C) was computed as:

$$C = \frac{W}{\alpha L^\beta}$$

2.4.6 Depth, temperature and salinity distribution of catches

For each category L species, We followed the methods developed by (Perry and Smith 1994) and generated cumulative frequency distributions of depth, temperature and salinity of survey catches.

2.4.7 Density-dependent habitat selection

We followed the methods of (Myers and Stokes 1989) to evaluate how fish abundance in each stratum varied with overall temporal fluctuations of population abundance.

For each category L species, we fitted a model of the relationship between stratum-level density and overall abundance (the yearly stratified random estimate of abundance, defined above). To properly use the observations of zero catch while accounting for the logarithmic distribution of catch abundance, we implemented the model as a generalised linear using a log link and a Poisson error distribution:

$$Y_{h,i} = \alpha_{h,i} Y_i^{\beta_{h,i}}$$

where, $y_{h,i}$ is the average abundance of stratum h in year i , and $\alpha_{h,i}$ and $\beta_{h,i}$ are the fitted parameters. The estimated parameter $\beta_{h,i}$ is referred to as the “slope parameter” and indicates whether stratum-level density is positively ($\beta_{h,i} <= 0$), negatively ($\beta_{h,i} >= 0$) or negligibly ($\beta_{h,i} \approx 0$) related to population abundance.

To estimate the suitability of each stratum, the median abundance observed during the years that are in the top 25% of yearly estimates is used. We combine the slope parameter estimates from the above model with the median abundance to identify strata that have consistently high abundance and whose local density is weakly related to fluctuation in population abundance ($\beta_{h,i} \approx 0$). Preferred strata are identified for each category L species.

3 Results

The plots generated for each species are presented in the Appendix.

3.1 Description of Figures

3.1.1 Type A

For Category L and S species:

Spatial distribution of catch-per unit of effort, (CPUE, kilograms per tow) in July-August for the Bay of Fundy and Scotian Shelf in five-year periods. Spatial interpolation between tows was done using Inverse Distance Weight (IDW). The probability of occurrence (proportion of tows with catch records for a given species) was also reported for each five-year period.

For Category LR and SR:

Location of tows with catch over the period 1970-2012 (Type LR) or the period 1999-2012 (Type SR). Location of tows with catch over the period 1970-2012 (Type LR) or the period 1999-2012 (Type SR).

3.1.2 Type B

For Category L, S and I species:

Stratified random estimate of CPUE (left panel), distribution indices (D75% and D95%, the minimum area containing 75% and 95% of biomass, middle panel), and distribution vs. weight per tow (right panel). The stratified random mean is plotted as a solid line with the 95% confidence region indicated by the solid grey line. The overall mean is plotted as a grey horizontal line and the overall mean plus or minus 50% of the standard deviation appear as horizontal dashed lines. In all three panels, the early years appear in blue and the last years appear in red. The predictions from a loess estimator are overlaid on the distribution indices (middle panel). The Pearson correlation coefficient between D75% and biomass, and its statistical significance, are also reported in the right panel.

3.1.3 Type C.

Length frequency distribution for NAFO divisions 4X and 4VW. A smoothed length frequency distribution is shown for each 7-year periods covered by the surveys.

3.1.4 Type D.

Average fish condition for all fish lengths (black dots and black line), large fish (thick gray line), and small fish (thin gray line). Fish condition is presented for NAFO divisions 4VW (right panel) and 4X (left panel).

3.1.5 Type E.

Cumulative frequency distributions of depth, temperature and salinity at all sampled locations (thick solid line) and at fishing locations with catch records (thin dashed line). The depth, temperature and salinity associated with 5%, 25%, 50%, 75% and 95% of the cumulative catch is shown in tabular fashion on the bottom right panel.

3.1.6 Type F.

Slopes estimates from the density-dependent habitat selection model (y axis) plotted versus the median abundance during the top 25% of years. The red box indicates strata of particular importance for a species by identifying slopes that are within a standard error from zero and that are within the top 25% of median abundance. Each stratum is identified on the plot by the last two digits of its number.

3.2 Summary of successful tows by year and stratum

There is something weird going on here, there are 2 tows with NAs for stratum, (HAM1980042 set 62 and HAM1982072 set 13).

Table 3. Number of representative tows conducted in each stratum during the period 1970 to 1991.

Stratum	NAFO Div.	Area (km ²)	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
440	4VN	3173.016	4	2	2	3	3	3	3	3	3	3	3	3	3	3	3	4	5	5	5	6	4	4
441	4VN	3434.000	4	2	2	3	3	3	1	3	3	3	3	3	3	3	3	5	5	4	4	4	6	5
442	4VN	4934.658	3	2	2	2	3	3	2	3	3	3	3	3	3	3	3	3	5	6	7	5	5	5
443	4VSW	4526.012	4	2	4	4	8	3	1	2	4	4	4	3	5	4	4	4	6	6	5	2	4	2
444	4VSW	13478.450	3	2	5	4	6	4	6	7	4	4	4	5	5	6	4	4	6	6	3	6	7	8
445	4VSW	3512.982	5	2	5	4	5	5	1	3	4	4	4	5	5	3	4	5	6	4	4	4	4	4
446	4VSW	1686.094	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	3	3	3	3
447	4VSW	5549.344	4	2	6	5	7	4	4	3	4	4	5	4	4	4	4	4	5	7	6	6	8	7
448	4VSW	4975.866	5	2	5	4	5	4	4	4	4	4	4	6	4	4	4	4	5	5	5	5	9	6
449	4VSW	494.496	2	2	2	2	3	2	2	2	1	2	2	2	1	2	2	2	2	2	2	2	2	2
450	4VSW	1315.222	2	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
451	4VSW	504.798	1	2	2	2	2	2	2	2	2	3	2	2	3	2	2	2	2	2	2	2	2	2
452	4VSW	1184.730	2	2	2	2	2	2	2	2	2	2	2	4	2	2	2	2	2	2	2	2	2	2
453	4VSW	889.406	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	3
454	4VSW	1713.566	3	2	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	2	2	3	2
455	4VSW	7286.948	7	6	7	6	7	6	6	7	7	7	7	7	7	7	7	7	8	8	7	7	12	10
456	4VSW	3279.470	5	4	6	5	5	6	4	6	6	6	7	6	6	6	6	6	7	6	6	10	7	7
457	4VSW	2784.974	2	2	2	2	3	2	2	2	2	2	2	3	2	2	2	2	2	4	2	2	4	2
458	4VSW	2259.572	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	5	5	3	3	8
459	4VSW	10810.232	3	2	4	4	4	4	4	4	4	4	4	4	4	4	4	4	6	6	5	6	5	5
460	4VSW	4615.296	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	4	3	3	3	3
461	4VSW	3962.836	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2	2	1
462	4VSW	7266.344	3	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	6	5	4	4	5
463	4VSW	1037.068	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	3
464	4VSW	4453.898	4	3	5	3	3	6	5	5	5	5	5	5	5	4	5	5	7	6	5	5	9	7
465	4VSW	8183.222	6	5	5	4	5	4	5	5	5	5	5	5	7	6	5	5	5	8	8	8	12	9
466	4VSW	776.084	2	2	3	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	2	2	3	2
470	4X	3159.280	1	2	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	2
471	4X	3447.736	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
472	4X	4289.066	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	4	4	6
473	4X	910.010	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2
474	4X	552.874	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
475	4X	535.704	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
476	4X	5075.452	2	2	2	2	2	2	3	2	2	2	1	2	2	2	2	2	2	2	4	4	4	4
477	4X	4230.688	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	5	4	4	5
478	4X	800.122	2	2	3	2	3	3	3	3	2	3	3	3	3	3	3	3	3	3	2	2	2	
480	4X	2249.270	4	4	4	4	3	3	3	4	4	3	4	3	3	4	4	4	4	4	4	4	8	
481	4X	6438.750	5	3	4	4	4	3	4	4	5	4	3	4	4	4	4	4	4	6	7	6	8	
482	4X	3578.228	2	1	2	2	2	2	2	3	2	2	3	2	2	2	2	2	2	2	3	3	3	
483	4X	1826.888	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
484	4X	7774.576	2	2	3	3	3	3	3	3	2	3	3	3	4	3	3	3	4	4	4	3	3	
485	4X	5432.588	2	2	2	3	3	3	3	3	3	3	3	3	4	3	3	3	3	6	7	6	2	
490	4X	2063.834	2	2	2	2	2	3	3	3	3	2	3	3	3	3	3	3	3	4	4	4	4	
491	4X	2359.158	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	
492	4X	3729.324	3	2	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	3	
493	4X	1830.322	1	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	
494	4X	1431.978	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
495	4X	2005.456	2	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	
171809.888		134	110	146	134	153	143	135	144	141	147	145	150	150	146	143	152	171	188	177	170	213	189	

Table 4. Number of representative tows conducted in each stratum during the period 1992 to 2013.

Stratum	NAFO Div.	Area (km ²)	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	
440	4VN	3173.016	4	3	4	4	4	4	4	4	6	4	4	4	4	4	4	4	3	4	4	5	4	4	
441	4VN	3434.000	5	5	5	5	5	5	6	7	6	6	7	6	7	6	6	5	6	6	7	6	6	6	
442	4VN	4934.658	6	5	6	6	6	6	7	6	6	5	6	7	5	5	5	5	5	6	5	6	6	6	
443	4VSW	4526.012	4	3	3	4	4	5	5	4	5	4	5	5	5	5	5	5	4	4	4	4	5	5	
444	4VSW	13478.450	8	9	6	8	8	7	8	8	9	10	9	9	9	8	10	8	6	9	11	13	9	8	
445	4VSW	3512.982	4	5	7	4	4	4	3	3	6	5	5	5	5	6	5	4	3	6	4	7	2	4	
446	4VSW	1686.094	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	4	3	3	
447	4VSW	5549.344	7	7	7	7	6	7	7	6	7	7	7	7	7	7	6	6	4	6	6	8	6	7	
448	4VSW	4975.866	6	7	7	7	6	7	6	7	8	8	8	8	7	8	8	6	5	7	7	10	8	8	
449	4VSW	494.496	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	4	2	2	
450	4VSW	1315.222	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
451	4VSW	504.798	2	2	2	2	4	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	
452	4VSW	1184.730	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
453	4VSW	889.406	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	1	2	2	1	3	2
454	4VSW	1713.566	2	2	2	2	2	3	2	2	2	2	2	2	2	3	2	2	2	2	2	4	2	2	
455	4VSW	7286.948	10	9	10	10	10	13	8	11	11	11	11	11	8	12	11	7	5	8	8	10	10	11	
456	4VSW	3279.470	7	8	8	8	8	8	8	6	8	10	8	8	8	8	8	6	2	7	7	9	8	8	
457	4VSW	2784.974	2	2	2	2	2	2	2	1	4	2	2	2	2	2	2	2	2	2	2	4	2	2	
458	4VSW	2259.572	8	8	8	8	7	8	5	6	10	8	7	8	8	10	8	5	2	7	6	9	8	6	
459	4VSW	10810.232	6	4	6	6	4	5	5	6	6	8	6	6	6	6	6	5	3	6	6	7	6	6	
460	4VSW	4615.296	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	2	3	3	4	4	3	
461	4VSW	3962.836	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4	2	2	2	2	3	3	2	
462	4VSW	7266.344	4	4	4	4	4	4	4	4	4	4	4	4	4	5	4	4	3	4	4	4	6	4	
463	4VSW	1037.068	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	3	2	2	
464	4VSW	4453.898	7	7	7	7	7	4	7	7	7	7	7	7	5	8	7	6	4	5	6	7	7	7	
465	4VSW	8183.222	10	10	10	10	10	10	9	10	10	10	10	10	10	10	10	7	8	7	8	10	10	10	
466	4VSW	776.084	2	2	2	3	2	2	3	2	2	2	2	2	2	2	2	2	1	3	2	2	2	2	
470	4X	3159.280	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	
471	4X	3447.736	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	
472	4X	4289.066	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	3	4	3	4	6	4	
473	4X	910.010	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
474	4X	552.874	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
475	4X	535.704	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
476	4X	5075.452	4	4	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4	4	4	4	
477	4X	4230.688	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	5	
478	4X	800.122	2	2	2	3	3	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	2	
480	4X	2249.270	8	8	8	8	8	8	8	8	7	8	8	8	7	9	8	6	8	8	8	7	8		
481	4X	6438.750	9	9	9	9	7	9	9	9	8	9	8	9	9	6	12	9	7	8	8	8	10	9	
482	4X	3578.228	3	3	3	3	3	3	3	3	3	3	3	3	3	2	4	3	3	3	3	4	3	3	
483	4X	1826.888	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	
484	4X	7774.576	3	3	3	3	3	3	3	3	3	3	3	3	3	4	3	3	4	3	3	5	5		
485	4X	5432.588	3	3	3	3	3	3	3	3	4	3	5	5	3	2	5	4	5	5	5	6	5		
490	4X	2063.834	4	4	4	5	4	4	4	3	4	4	4	4	6	4	3	3	4	3	3	4	2		
491	4X	2359.158	3	3	3	3	3	3	3	3	3	3	3	3	5	3	3	4	3	4	4	4	4		
492	4X	3729.324	3	3	3	2	3	3	3	3	3	3	3	3	5	2	3	4	4	4	4	6	4		
493	4X	1830.322	3	3	3	3	2	3	3	2	3	3	4	5	2	4	4	3	3	4	3	4	4		
494	4X	1431.978	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	4	4	4		
495	4X	2005.456	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	5	3	3	4	3	4		
171809.888		193	190	195	195	191	193	186	191	213	201	208	216	188	222	209	177	165	196	196	243	210	208		

Table 5. Number of representative tows conducted in each stratum during the period 2014 to 2020 and for the whole 1970 to 2020 period.

Stratum	NAFO Div.	Area (km ²)	2014	2015	2016	2017	2018	2019	2020	Total
440	4VN	3173.016	4	4	4	4	0	5	4	190
441	4VN	3434.000	6	6	6	6	0	7	4	238
442	4VN	4934.658	6	6	6	6	0	6	5	240
443	4VSW	4526.012	3	7	4	5	0	9	4	214
444	4VSW	13478.450	9	9	11	10	0	6	8	352
445	4VSW	3512.982	3	4	4	4	0	6	3	215
446	4VSW	1686.094	3	2	3	2	0	3	2	145
447	4VSW	5549.344	7	7	7	7	0	6	5	291
448	4VSW	4975.866	8	7	6	6	0	7	4	299
449	4VSW	494.496	2	2	2	2	0	2	2	100
450	4VSW	1315.222	3	3	3	2	0	3	2	144
451	4VSW	504.798	2	2	2	2	0	2	2	104
452	4VSW	1184.730	1	4	3	3	0	3	3	110
453	4VSW	889.406	3	2	2	1	0	2	2	116
454	4VSW	1713.566	2	2	2	2	0	3	2	121
455	4VSW	7286.948	11	9	9	8	0	9	6	429
456	4VSW	3279.470	6	5	6	6	0	6	4	331
457	4VSW	2784.974	2	3	3	3	0	3	2	113
458	4VSW	2259.572	4	5	5	5	0	6	3	269
459	4VSW	10810.232	6	7	7	6	0	9	7	262
460	4VSW	4615.296	3	5	5	5	3	6	5	151
461	4VSW	3962.836	2	3	3	3	2	3	3	113
462	4VSW	7266.344	5	5	5	5	0	5	5	212
463	4VSW	1037.068	2	3	2	2	0	2	2	107
464	4VSW	4453.898	7	6	6	4	0	6	4	288
465	4VSW	8183.222	10	10	9	7	3	10	7	397
466	4VSW	776.084	2	2	2	3	0	3	2	118
470	4X	3159.280	2	3	3	3	4	3	2	112
471	4X	3447.736	2	3	3	3	4	4	3	110
472	4X	4289.066	4	4	4	4	4	4	4	172
473	4X	910.010	2	2	2	2	2	2	2	104
474	4X	552.874	2	2	2	2	2	2	2	100
475	4X	535.704	2	2	2	2	2	2	2	103
476	4X	5075.452	4	5	5	5	5	5	5	177
477	4X	4230.688	6	5	5	4	4	6	4	204
478	4X	800.122	2	2	2	3	2	2	2	119
480	4X	2249.270	6	7	7	7	5	7	5	306
481	4X	6438.750	9	8	10	9	6	9	6	350
482	4X	3578.228	3	3	4	4	3	4	3	141
483	4X	1826.888	2	2	3	3	2	3	2	105
484	4X	7774.576	4	6	5	7	7	7	7	186
485	4X	5432.588	5	6	6	6	4	6	5	196
490	4X	2063.834	3	4	4	4	3	4	3	173
491	4X	2359.158	4	4	4	4	3	4	3	168
492	4X	3729.324	4	3	4	4	3	4	4	171
493	4X	1830.322	3	3	4	6	3	3	3	159
494	4X	1431.978	3	4	4	3	2	4	3	128
495	4X	2005.456	2	4	4	4	3	4	3	127
		171809.888	196	212	214	208	81	227	175	9080

A total of 9080 representative tows were conducted for the period spanning from 1970 to 2020.

4 Discussion

The current document is not meant to replace stock assessments, species-specific analyses of abundance, biomass and distribution, or any targeted attempts to integrate information about species or group of species from the wide and disparate sources of data about marine organisms in the area covered by the DFO Maritimes summer trawl survey. It is rather meant to provide a reproducible set of tools to extract and visualise the information collected in the DFO Maritimes summer trawl survey.

It is hoped that this document can provide a stepping stone to conduct other ecological analyses using the trawl survey data.

5 Acknowledgements

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7 Appendix

7.1 Atlantic cod (*Morue franche*) - species code 10 (category LF)

Scientific name: [Gadus morhua](#)

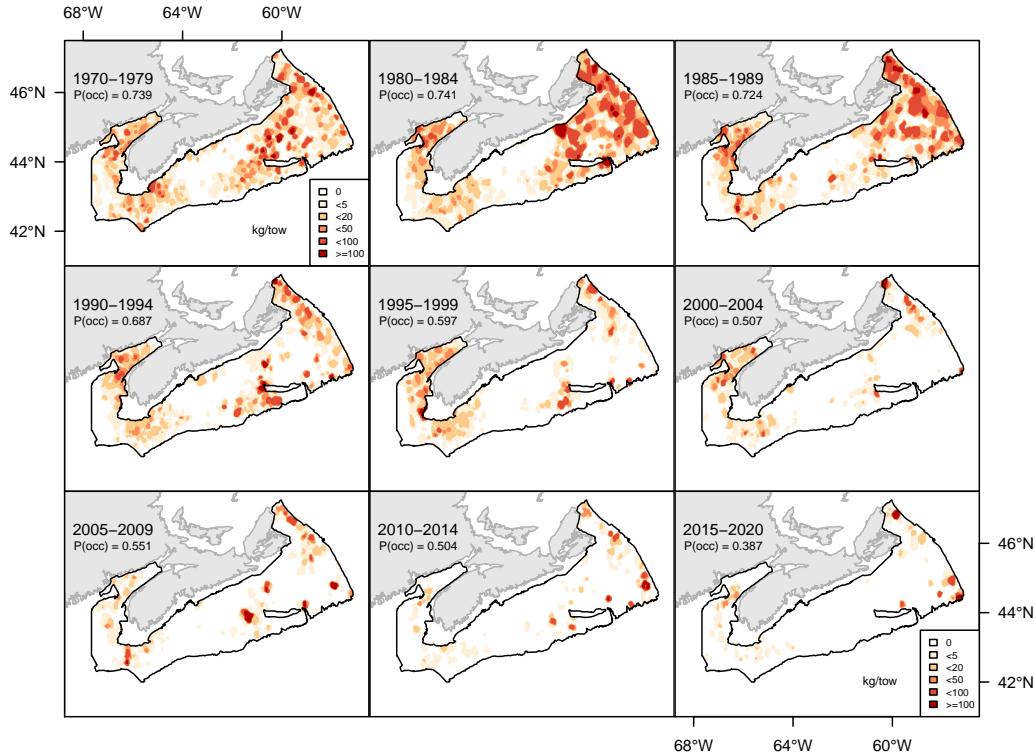


Figure 7.1A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic cod.

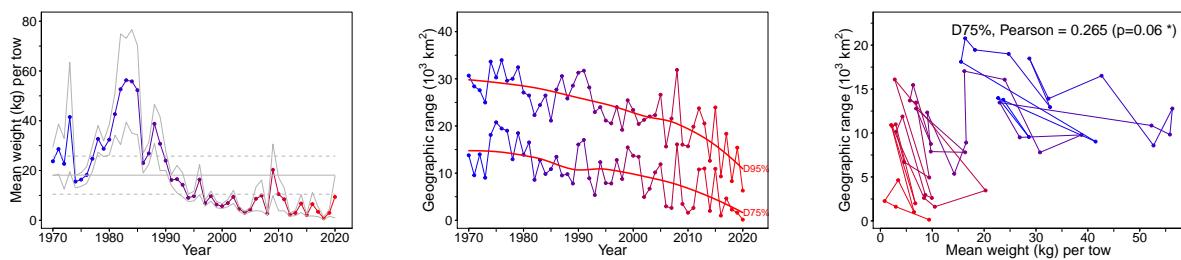


Figure 7.1B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic cod.

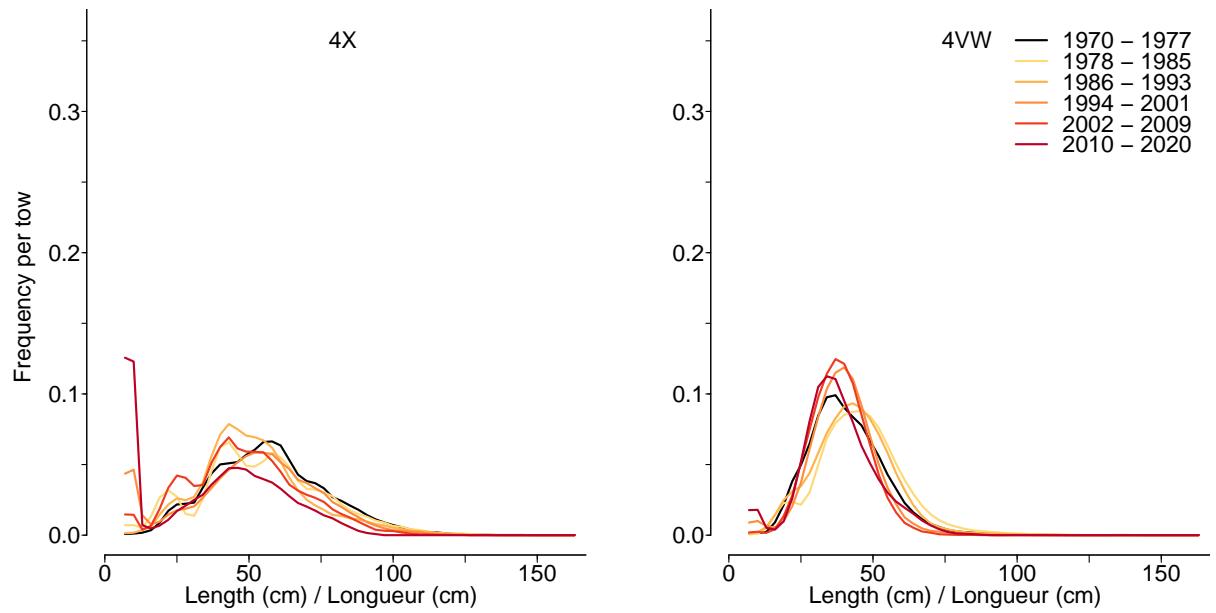


Figure 7.1C. Length frequency distribution in NAFO units 4X and 4VW for Atlantic cod.

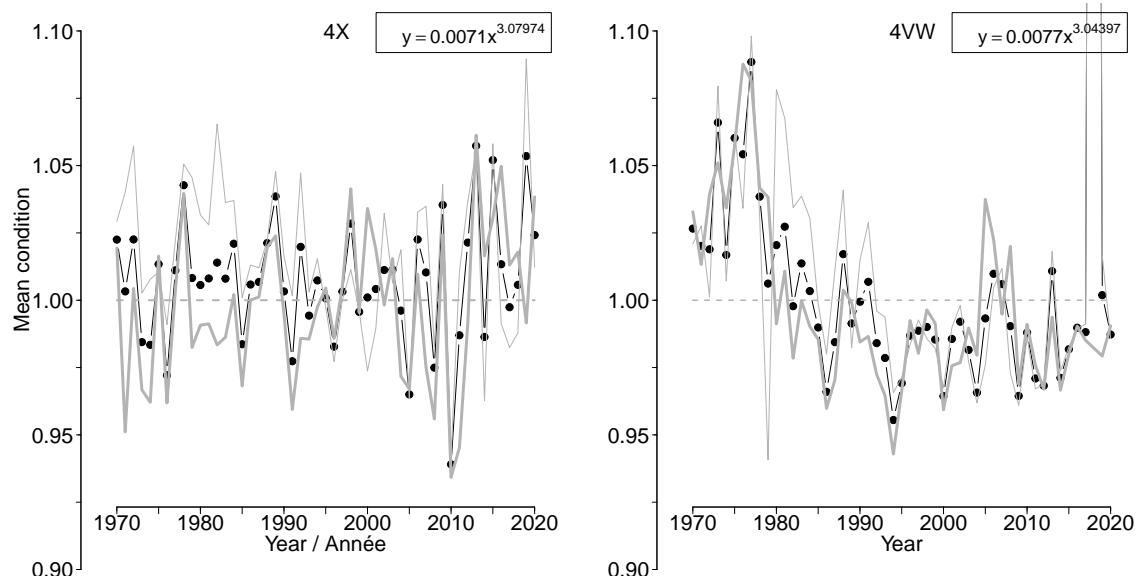


Figure 7.1D. Average fish condition in NAFO units 4X and 4VW for Atlantic cod.

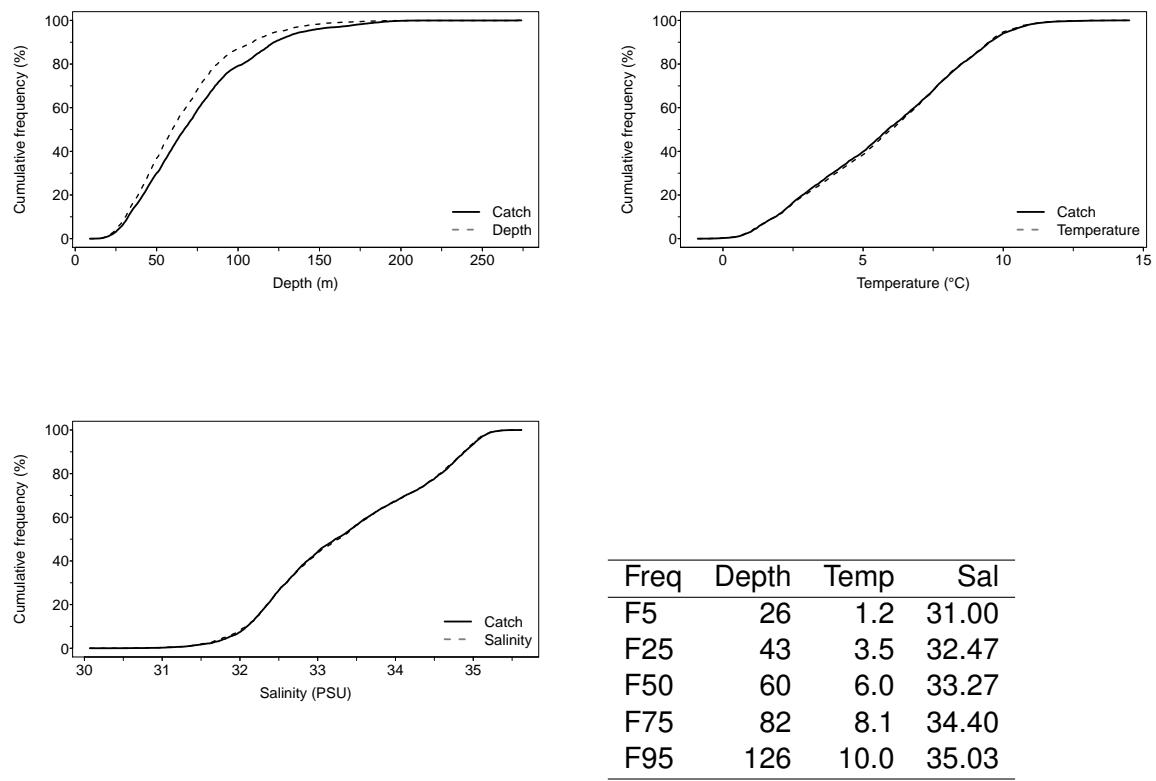


Figure 7.1E. Catch distribution by depth, temperature and salinity of Atlantic cod.

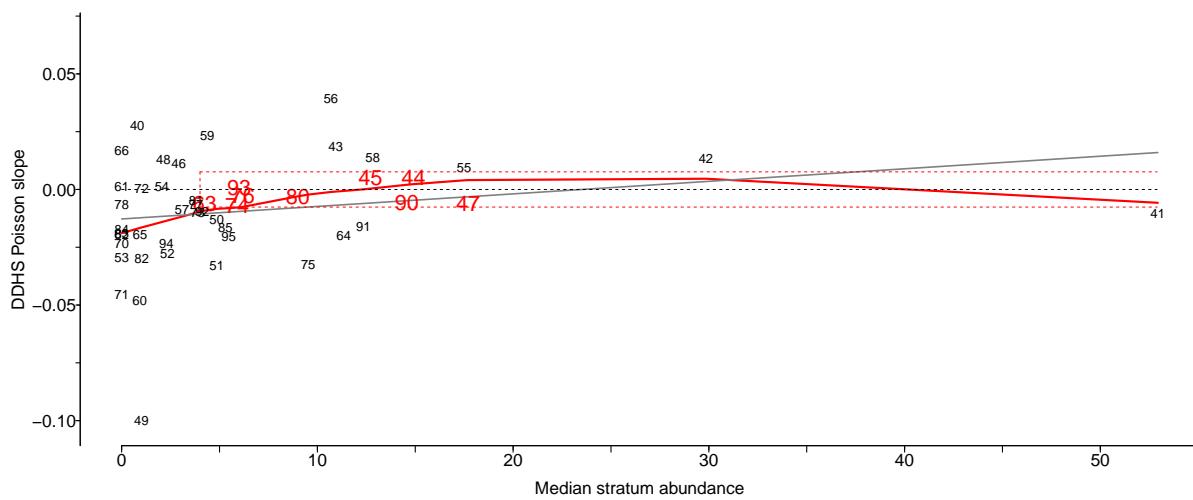


Figure 7.1F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Atlantic cod.

7.2 Haddock (Aiglefin) - species code 11 (category LF)

Scientific name: [Melanogrammus aeglefinus](#)

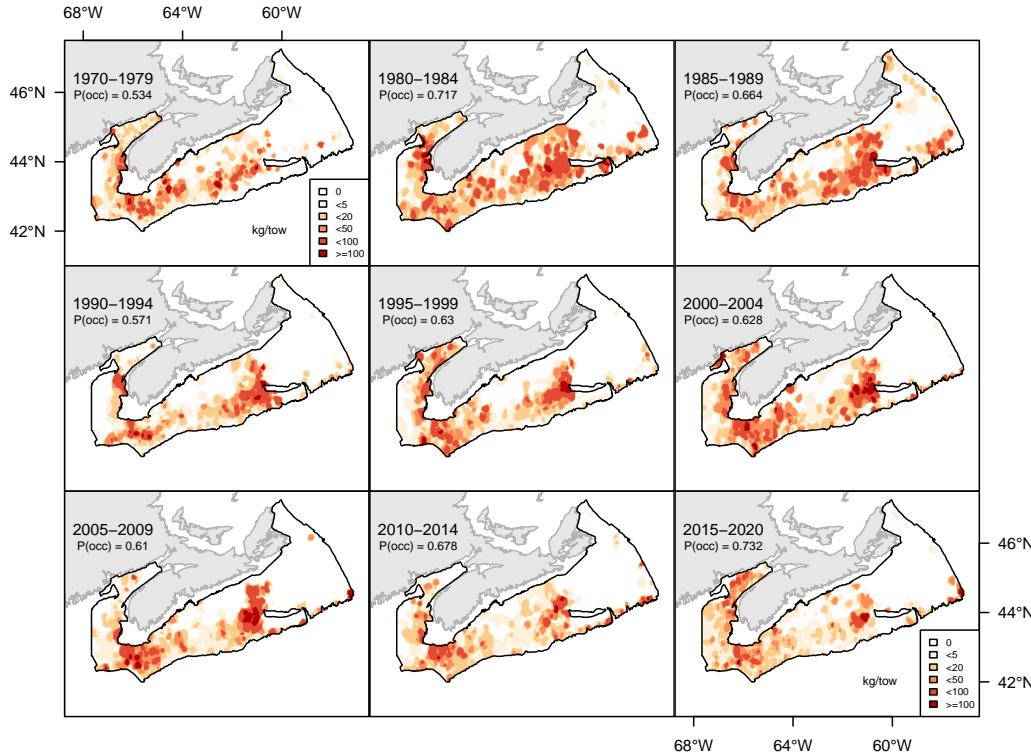


Figure 7.2A. Inverse distance weighted distribution of catch biomass (kg/tow) for Haddock.

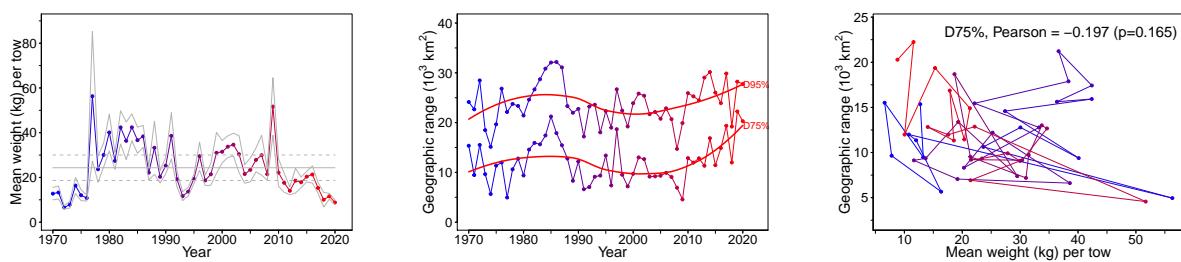


Figure 7.2B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Haddock.

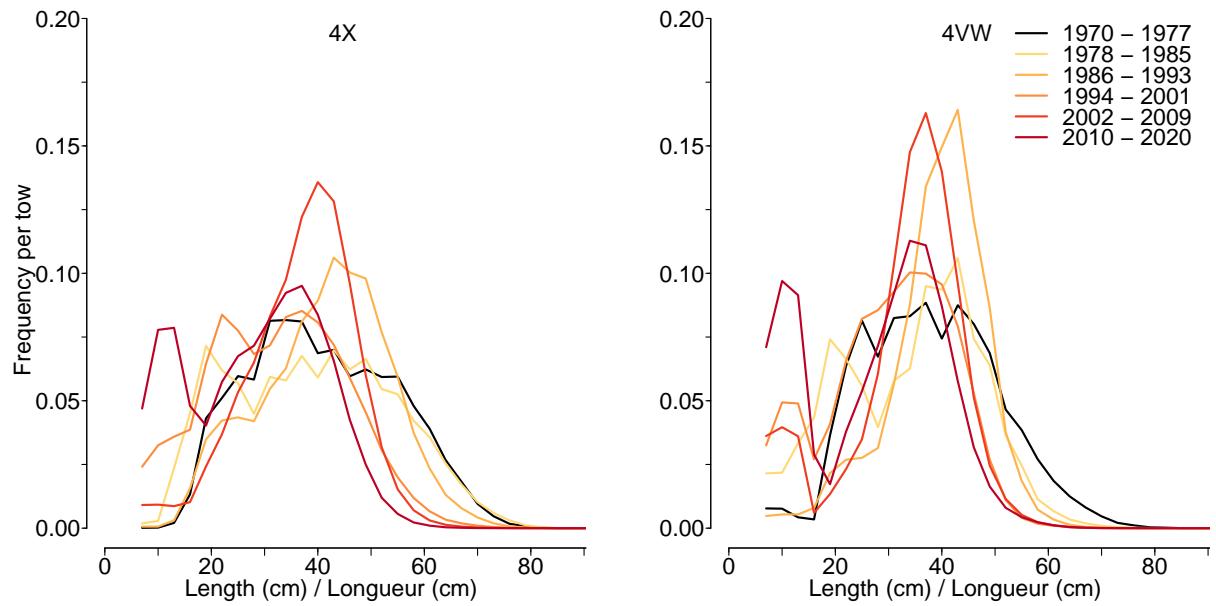


Figure 7.2C. Length frequency distribution in NAFO units 4X and 4VW for Haddock.

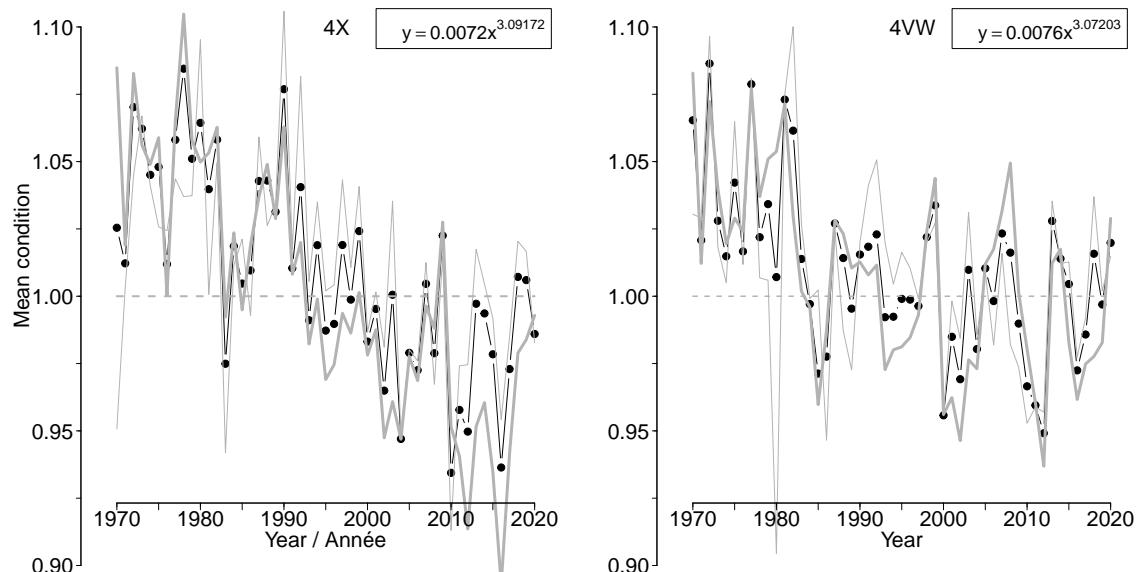


Figure 7.2D. Average fish condition in NAFO units 4X and 4VW for Haddock.

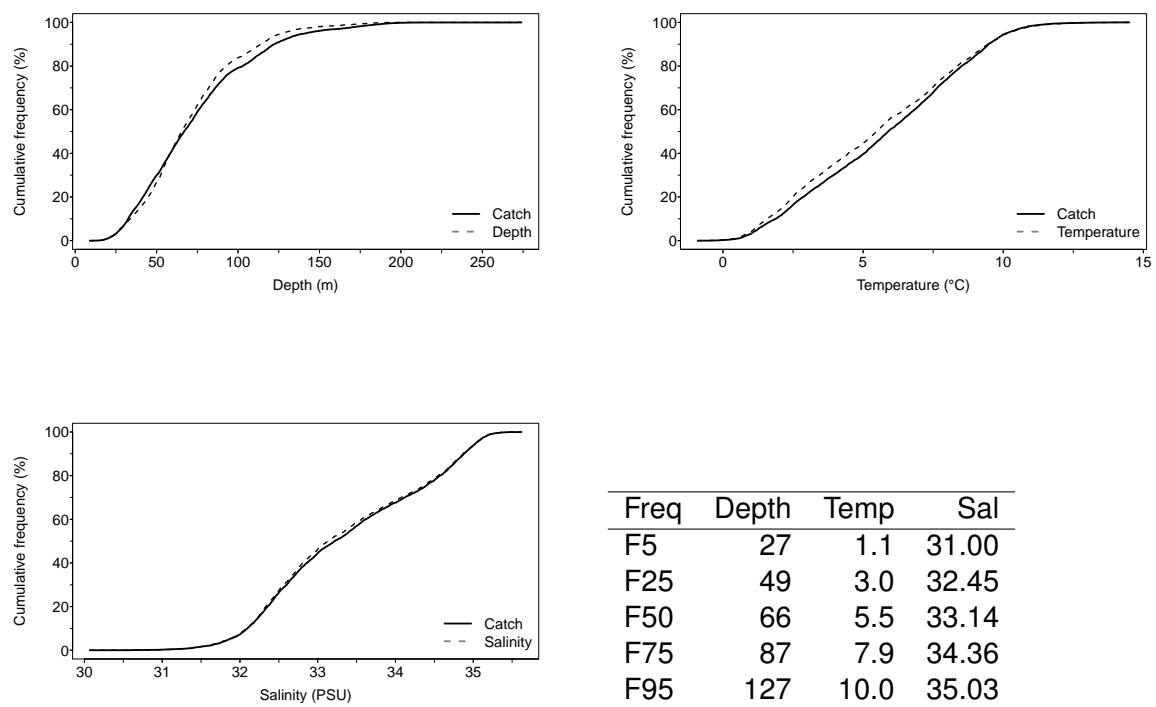


Figure 7.2E. Catch distribution by depth, temperature and salinity of Haddock.

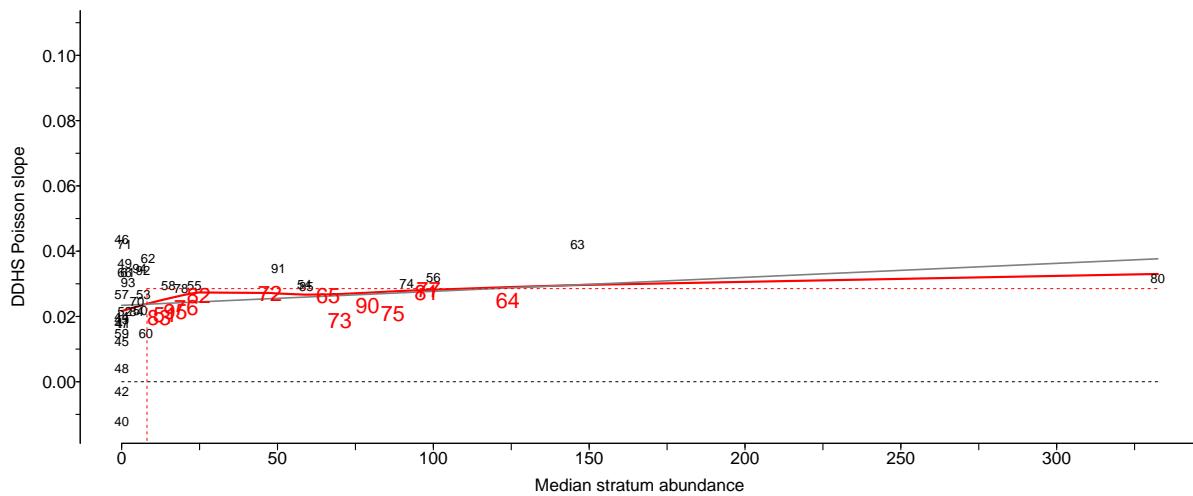


Figure 7.2F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Haddock.

7.3 White hake (Merluche blanche) - species code 12 (category LF)

Scientific name: [Urophycis tenuis](#)

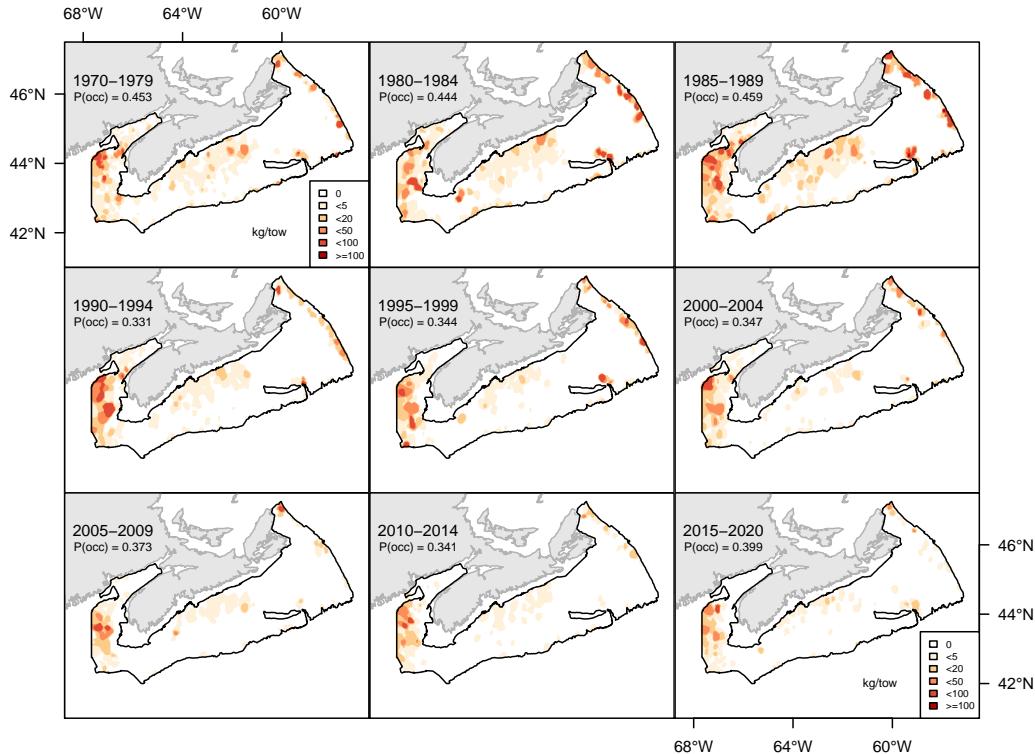


Figure 7.3A. Inverse distance weighted distribution of catch biomass (kg/tow) for White hake.

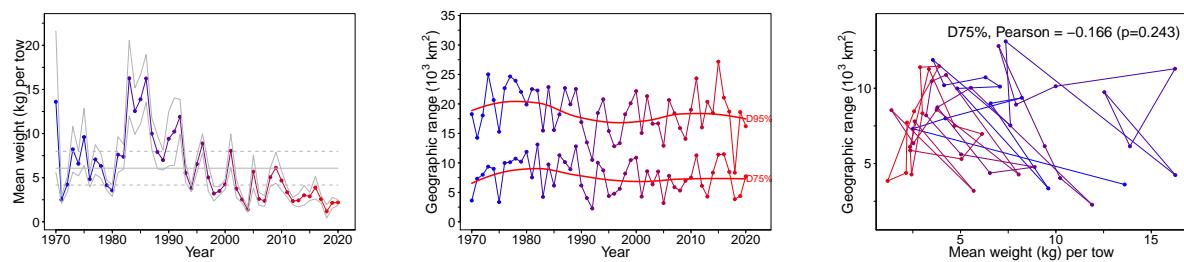


Figure 7.3B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of White hake.

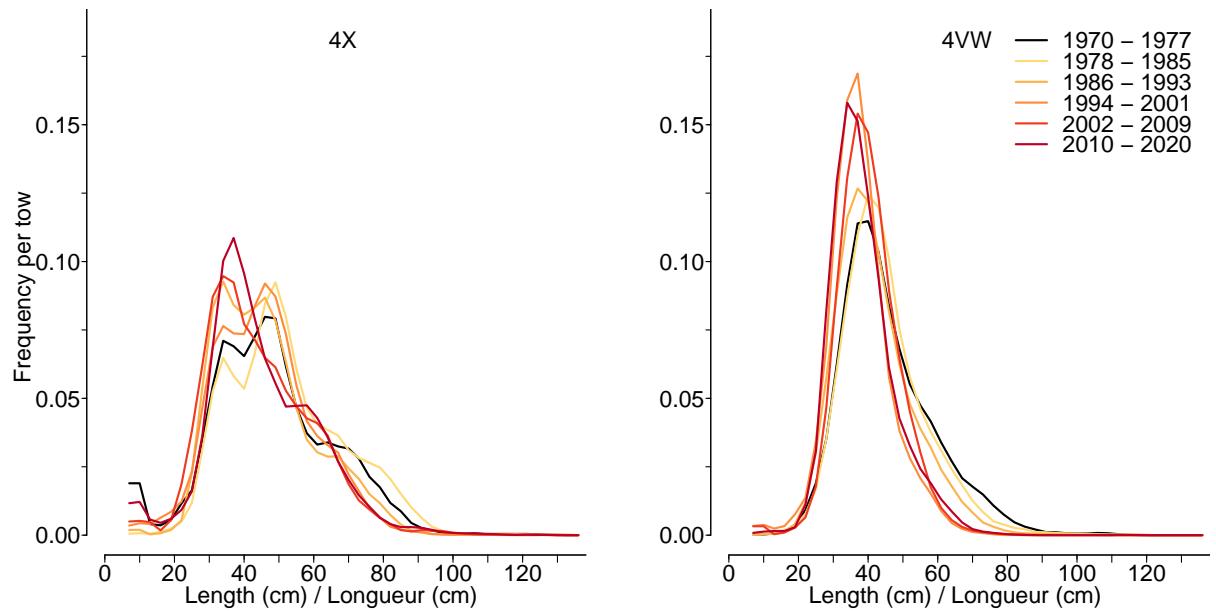


Figure 7.3C. Length frequency distribution in NAFO units 4X and 4VW for White hake.

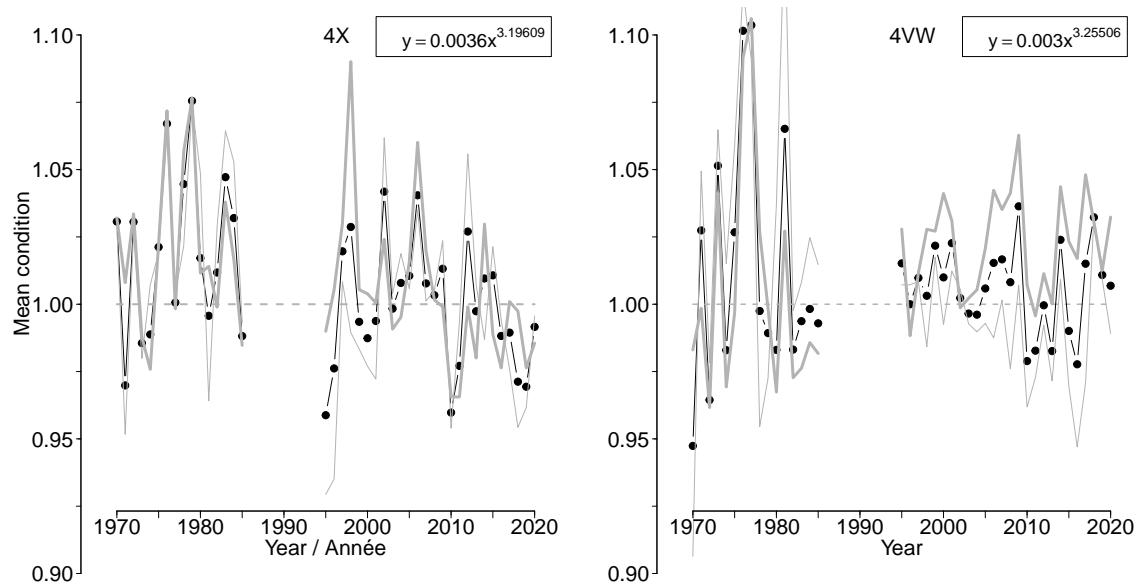
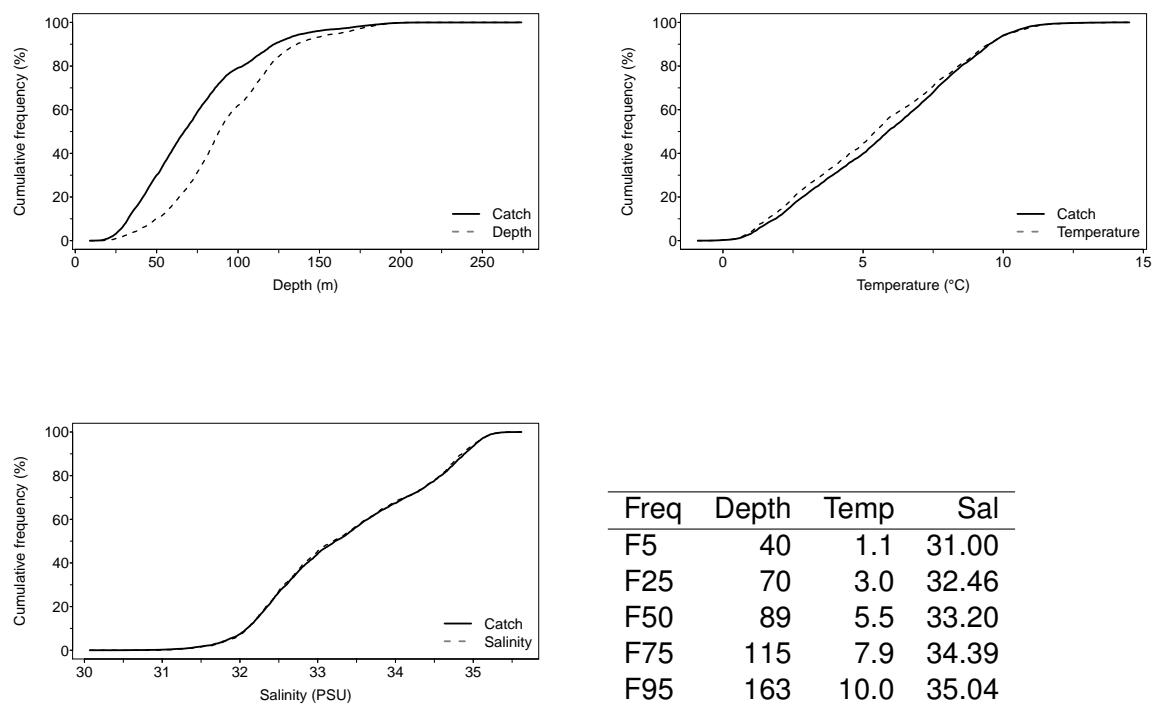


Figure 7.3D. Average fish condition in NAFO units 4X and 4VW for White hake.



Freq	Depth	Temp	Sal
F5	40	1.1	31.00
F25	70	3.0	32.46
F50	89	5.5	33.20
F75	115	7.9	34.39
F95	163	10.0	35.04

Figure 7.3E. Catch distribution by depth, temperature and salinity of White hake.

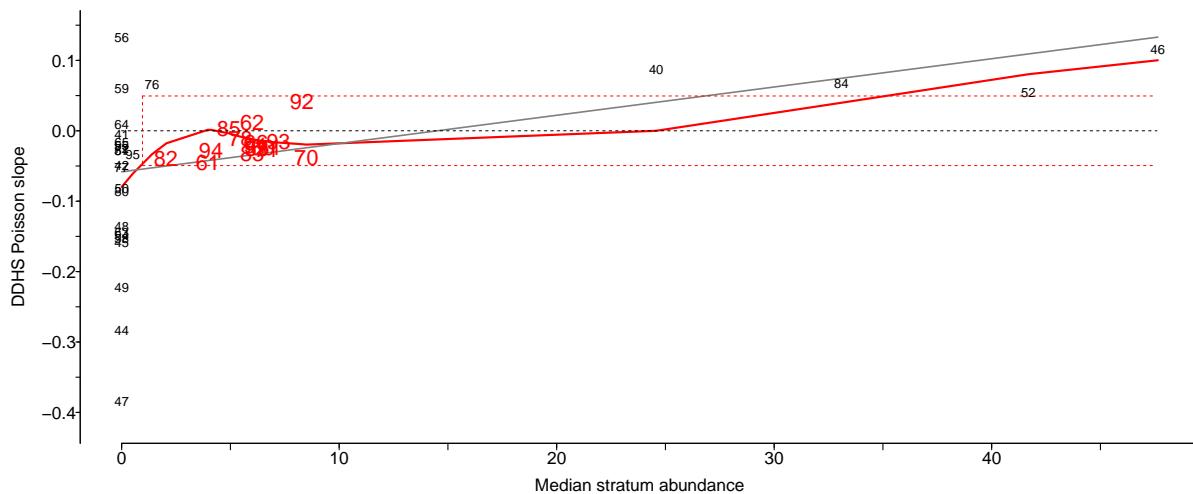


Figure 7.3F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for White hake.

7.4 Red hake (Merluche écureuil) - species code 13 (category LF)

Scientific name: [Urophycis chuss](#)

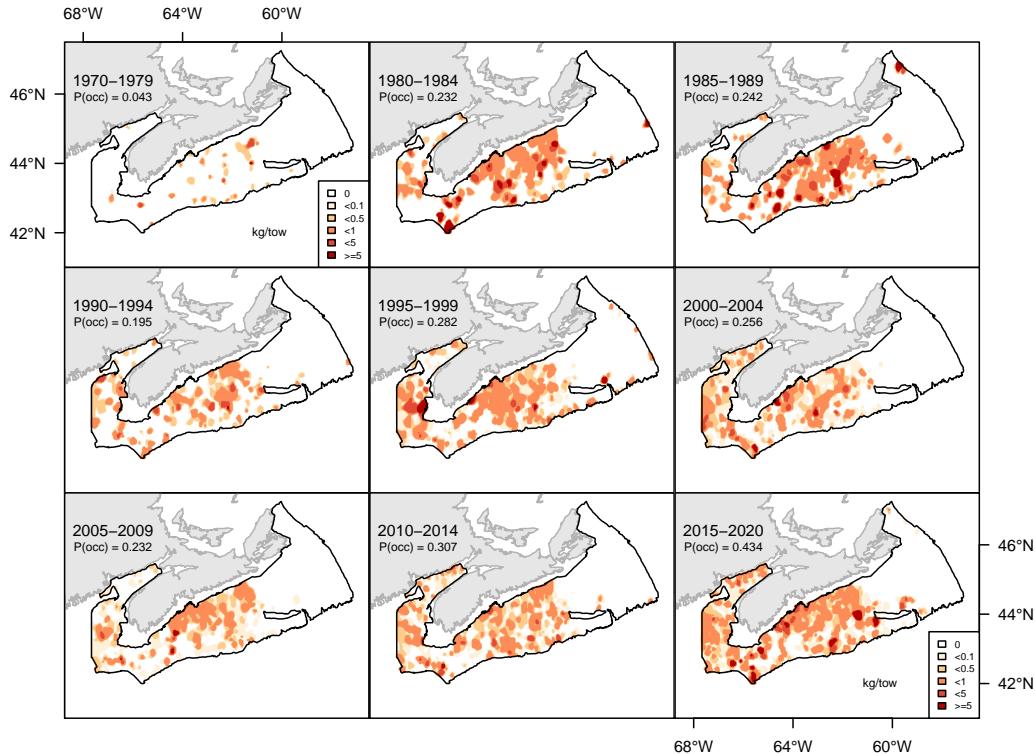


Figure 7.4A. Inverse distance weighted distribution of catch biomass (kg/tow) for Red hake.

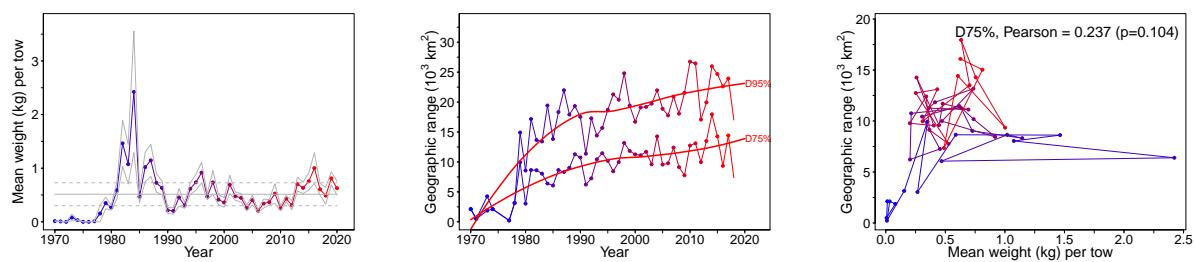


Figure 7.4B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Red hake.

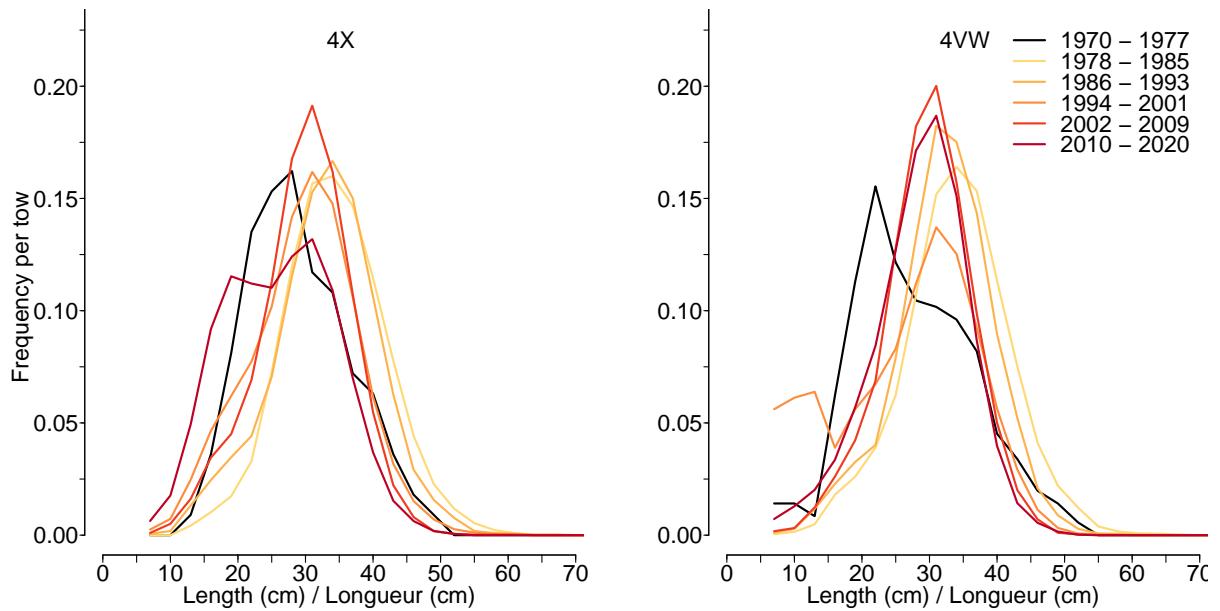


Figure 7.4C. Length frequency distribution in NAFO units 4X and 4VW for Red hake.

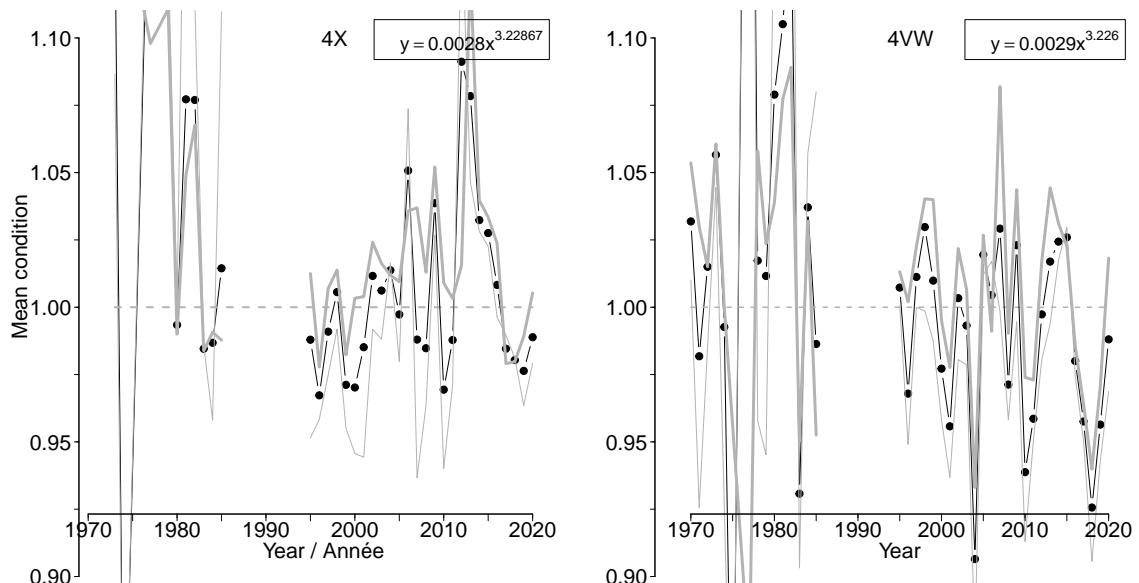


Figure 7.4D. Average fish condition in NAFO units 4X and 4VW for Red hake.

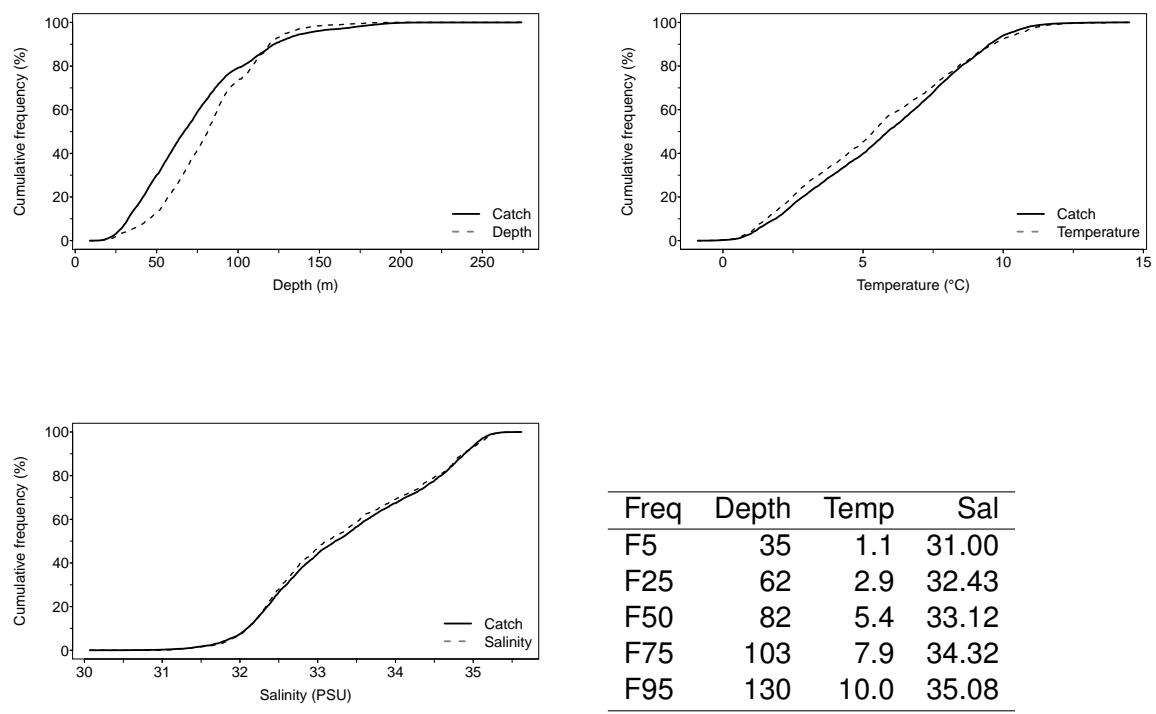


Figure 7.4E. Catch distribution by depth, temperature and salinity of Red hake.

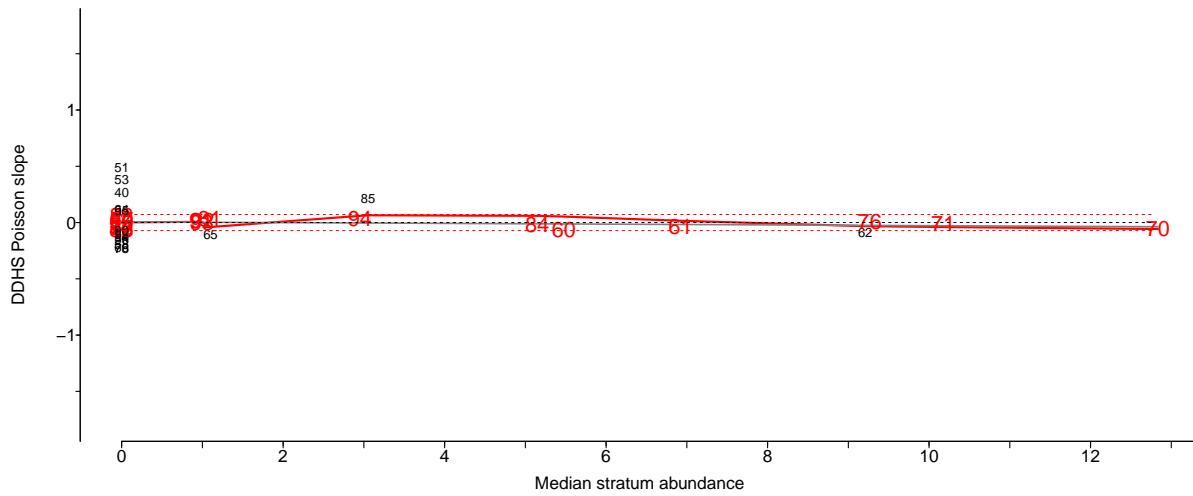


Figure 7.4F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Red hake.

7.5 Silver hake (*Merlu argenté*) - species code 14 (category LF)

Scientific name: [Merluccius bilinearis](#)

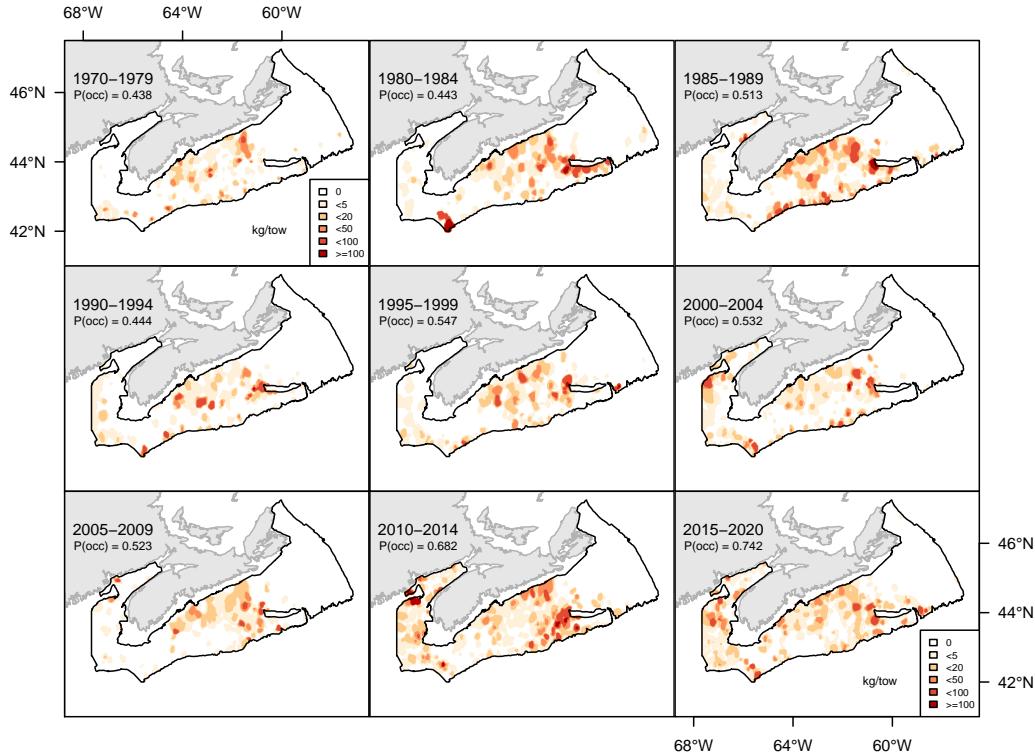


Figure 7.5A. Inverse distance weighted distribution of catch biomass (kg/tow) for Silver hake.

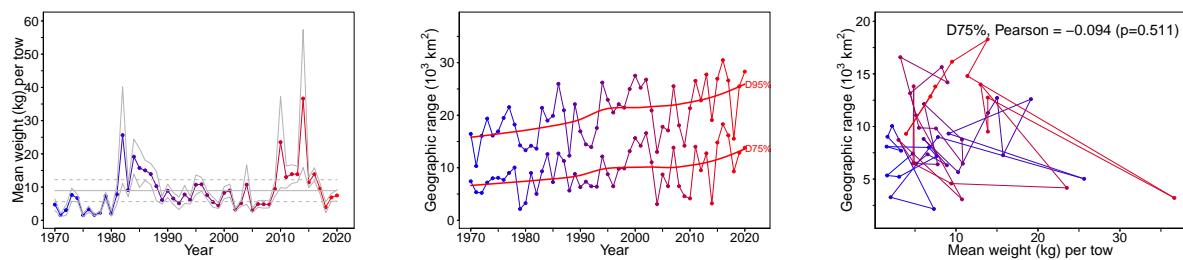


Figure 7.5B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Silver hake.

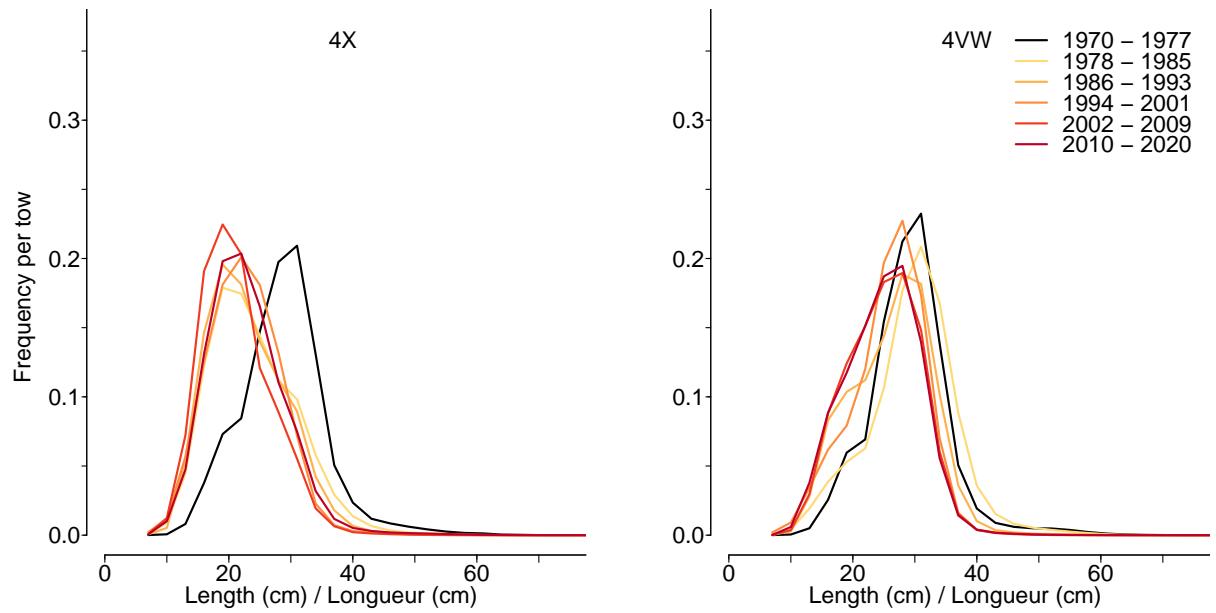


Figure 7.5C. Length frequency distribution in NAFO units 4X and 4VW for Silver hake.

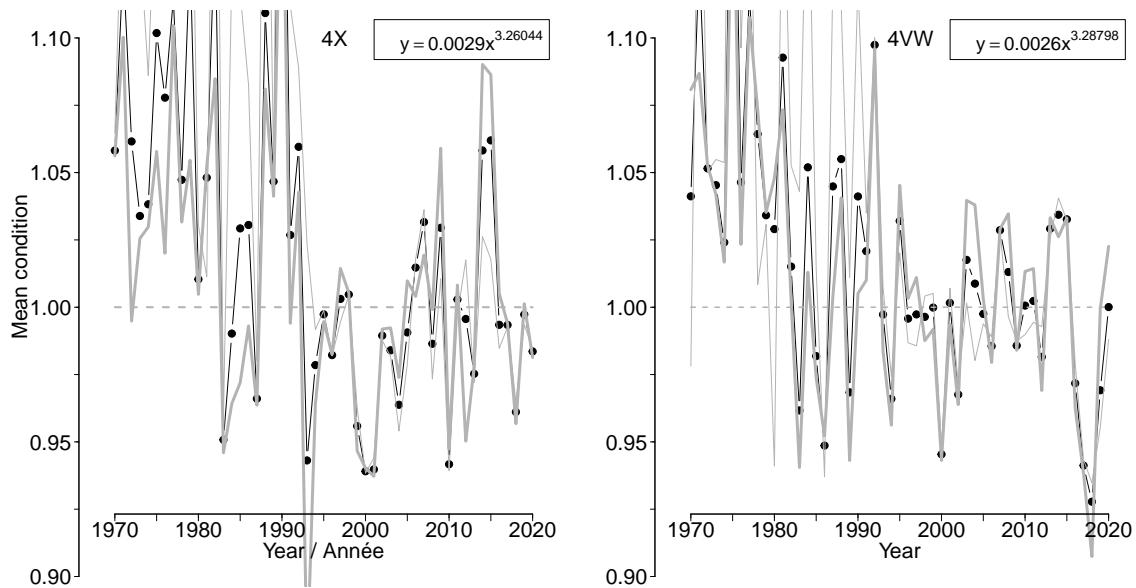


Figure 7.5D. Average fish condition in NAFO units 4X and 4VW for Silver hake.

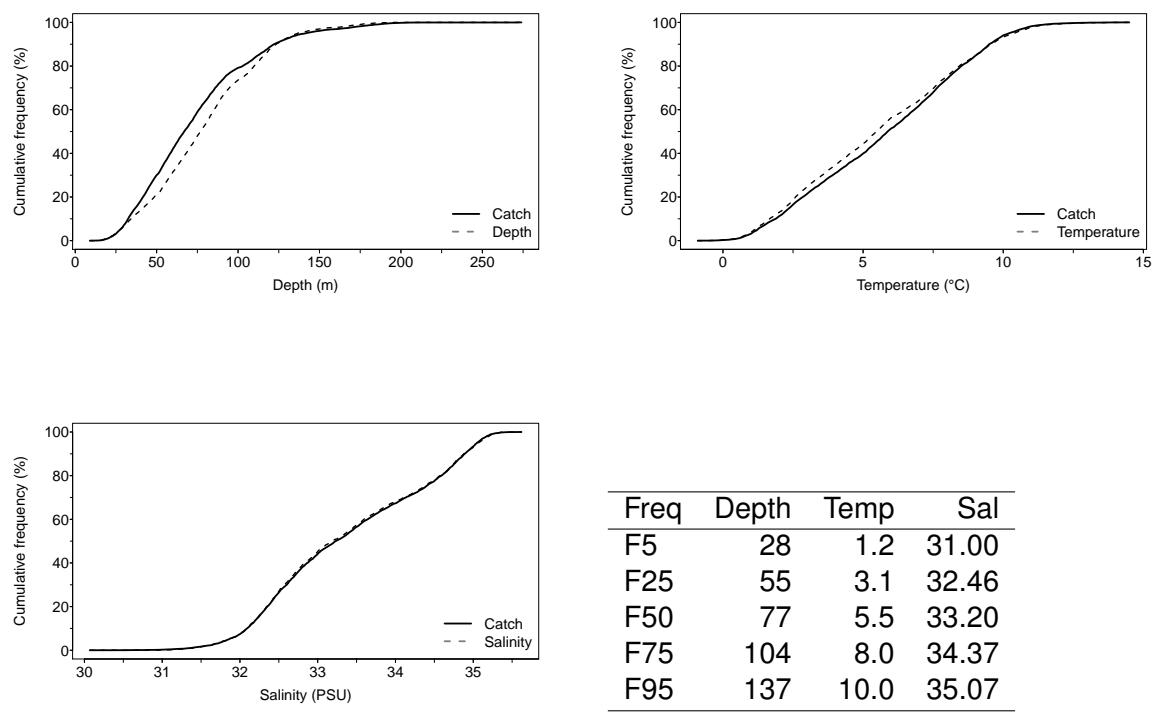


Figure 7.5E. Catch distribution by depth, temperature and salinity of Silver hake.

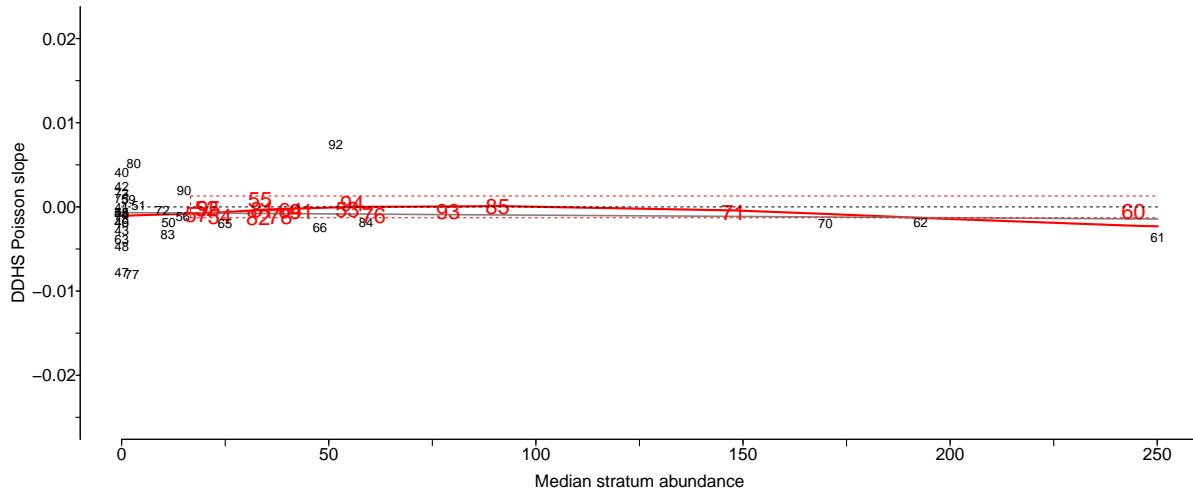


Figure 7.5F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Silver hake.

7.6 Pollock (Goberge) - species code 16 (category LF)

Scientific name: [Pollachius virens](#)

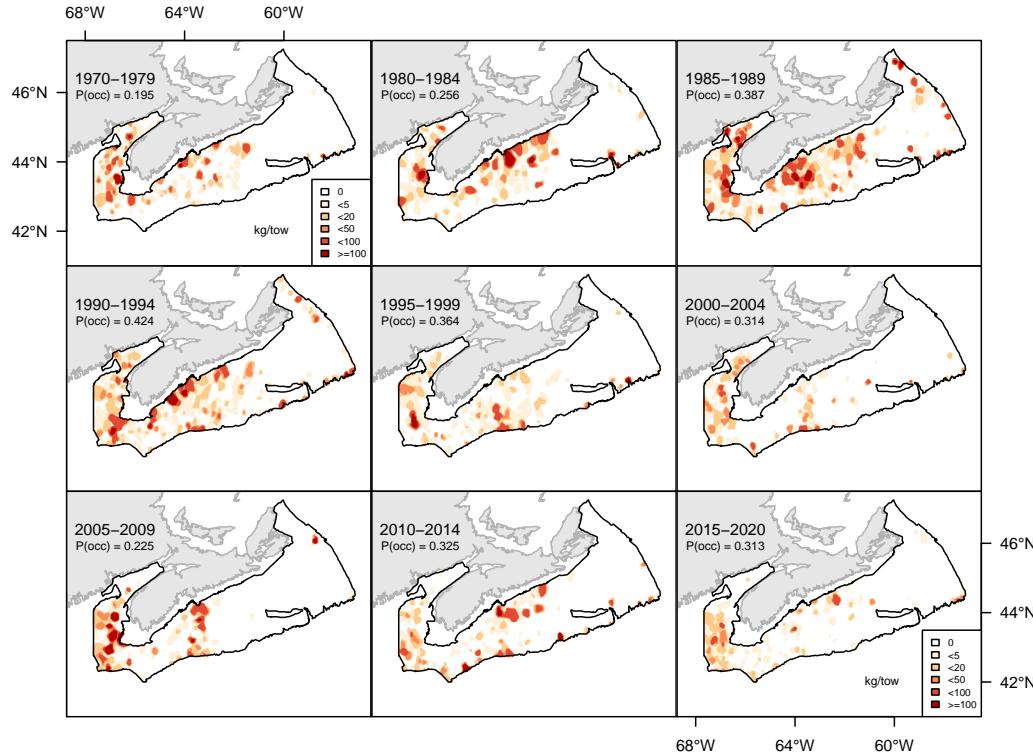


Figure 7.6A. Inverse distance weighted distribution of catch biomass (kg/tow) for Pollock.

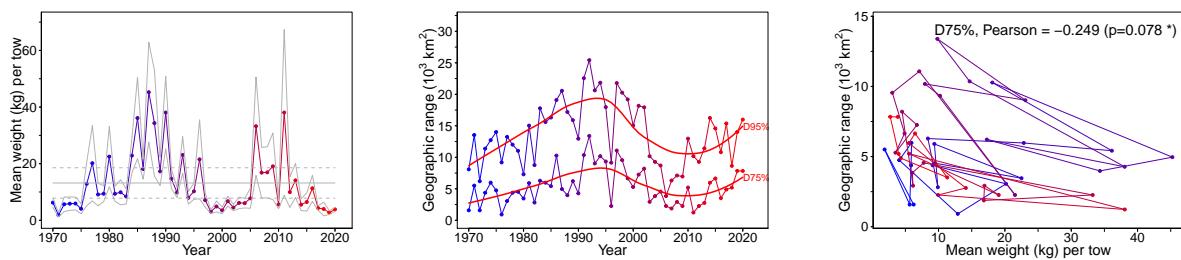


Figure 7.6B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Pollock.

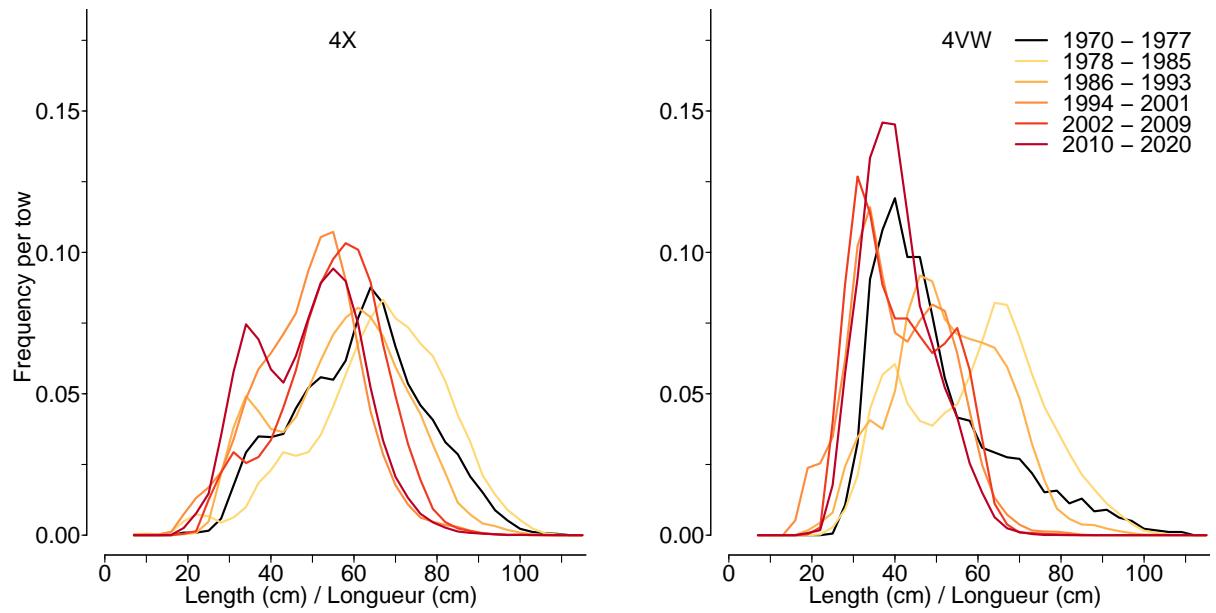


Figure 7.6C. Length frequency distribution in NAFO units 4X and 4VW for Pollock.

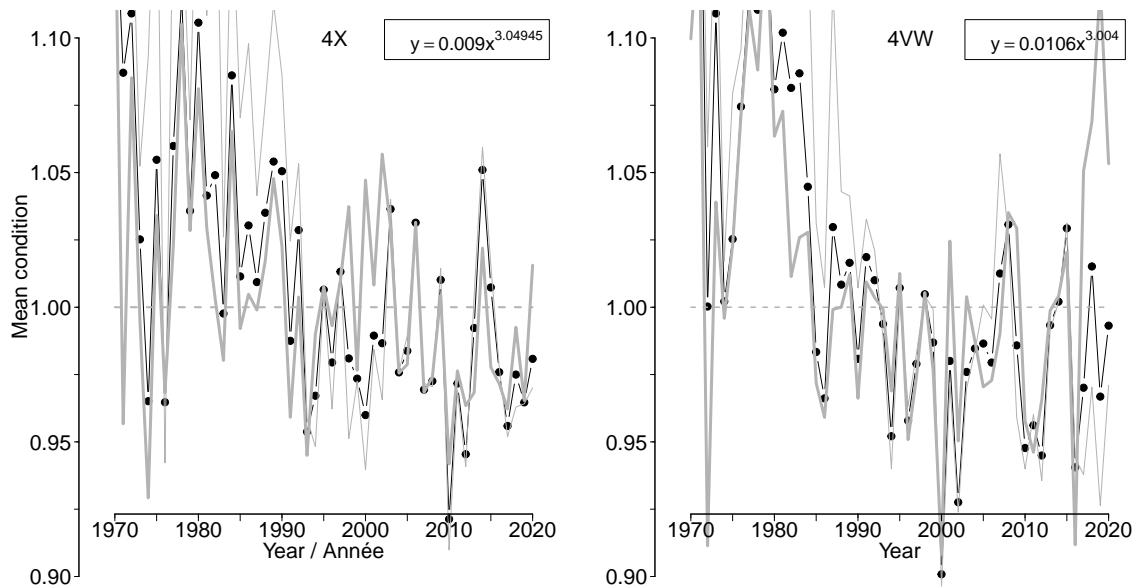


Figure 7.6D. Average fish condition in NAFO units 4X and 4VW for Pollock.

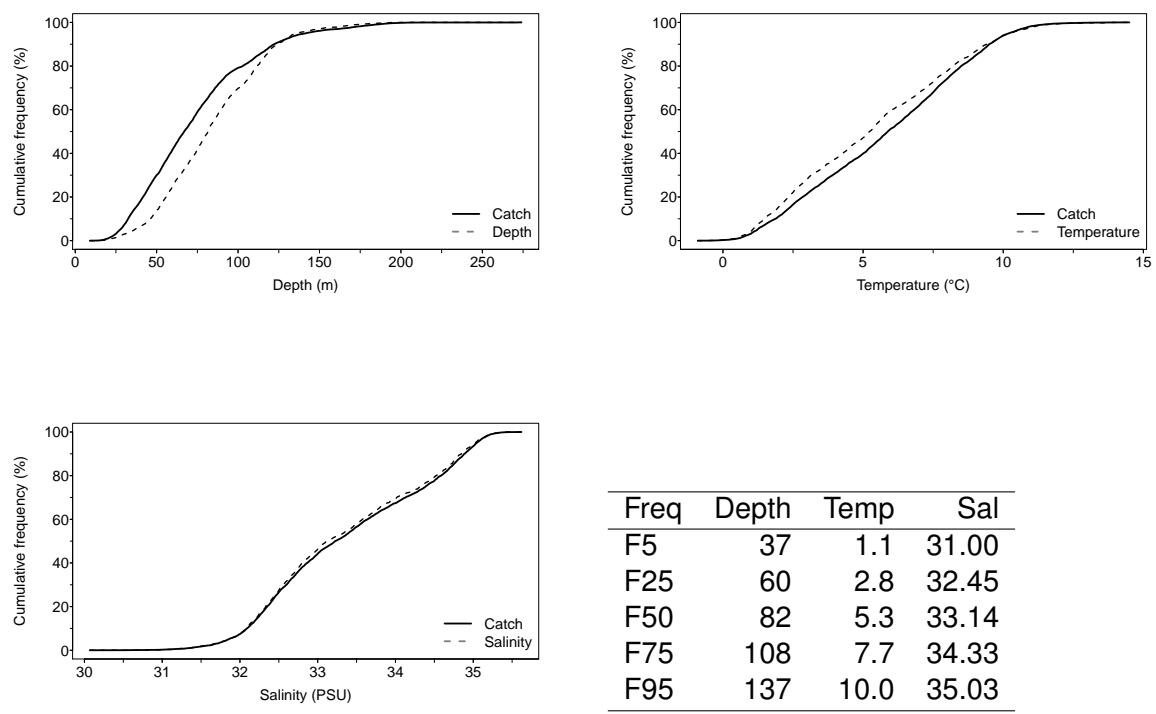


Figure 7.6E. Catch distribution by depth, temperature and salinity of Pollock.

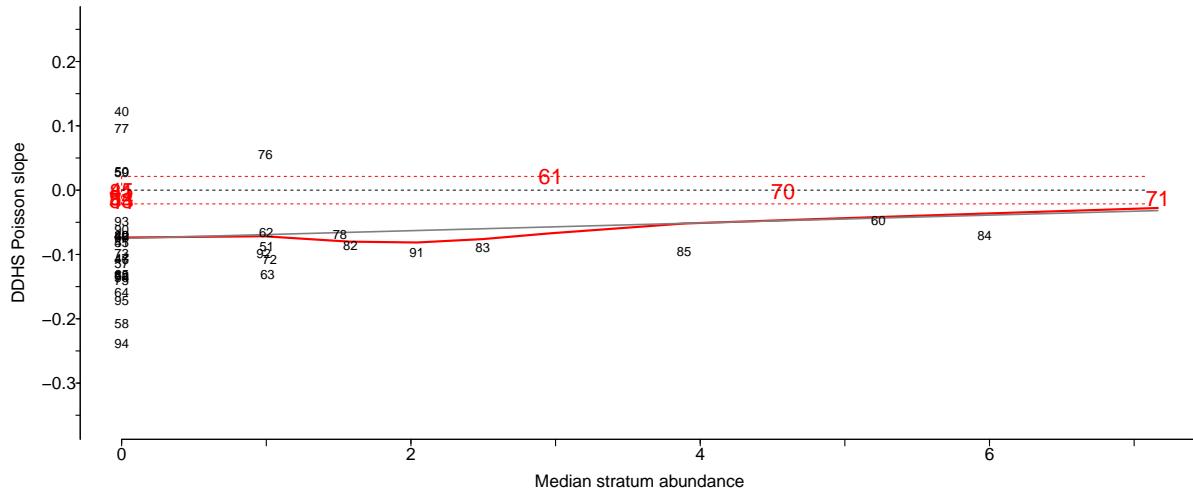


Figure 7.6F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Pollock.

7.7 Atlantic redfishes (Sébastes de l'Atlantique) - species code 23 (category LF)

Scientific name: [Sebastes](#)

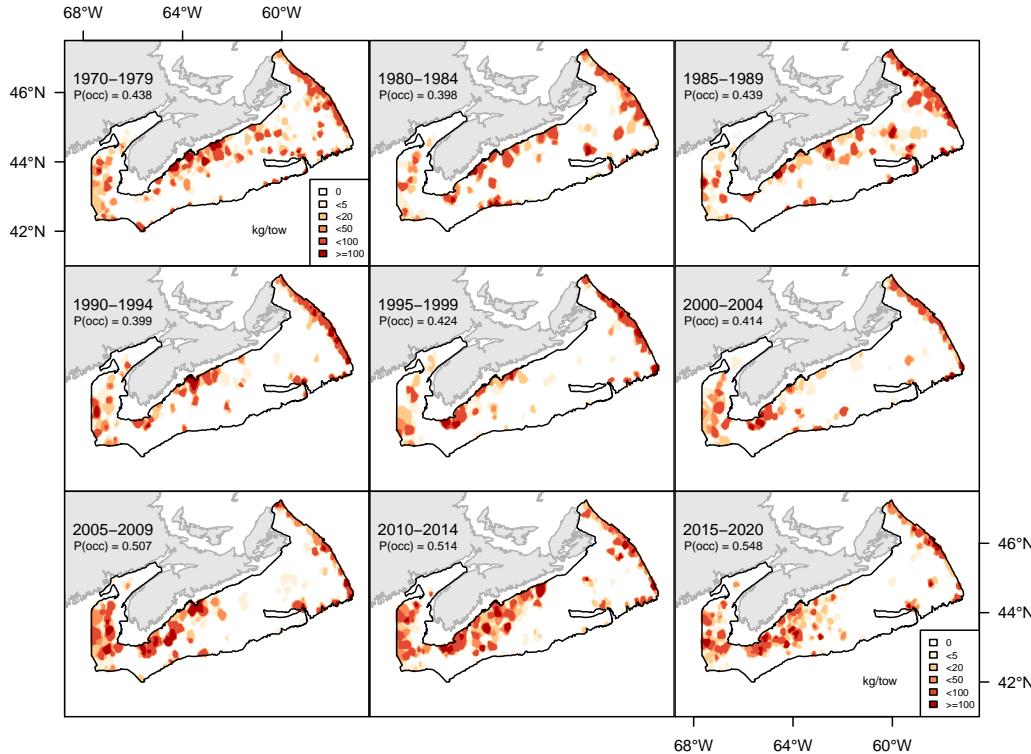


Figure 7.7A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic redfishes.

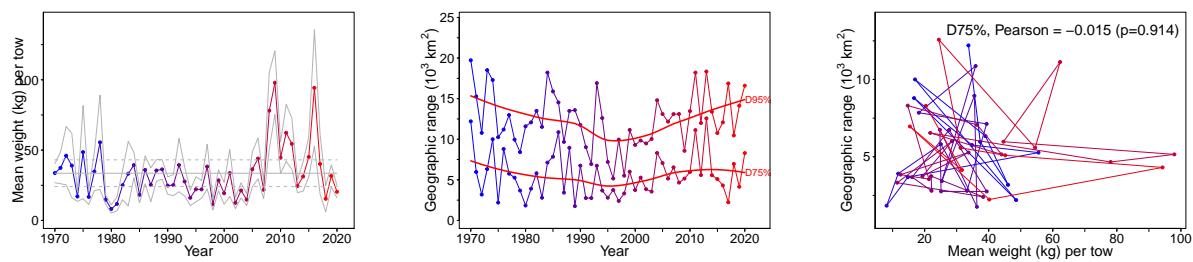


Figure 7.7B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic redfishes.

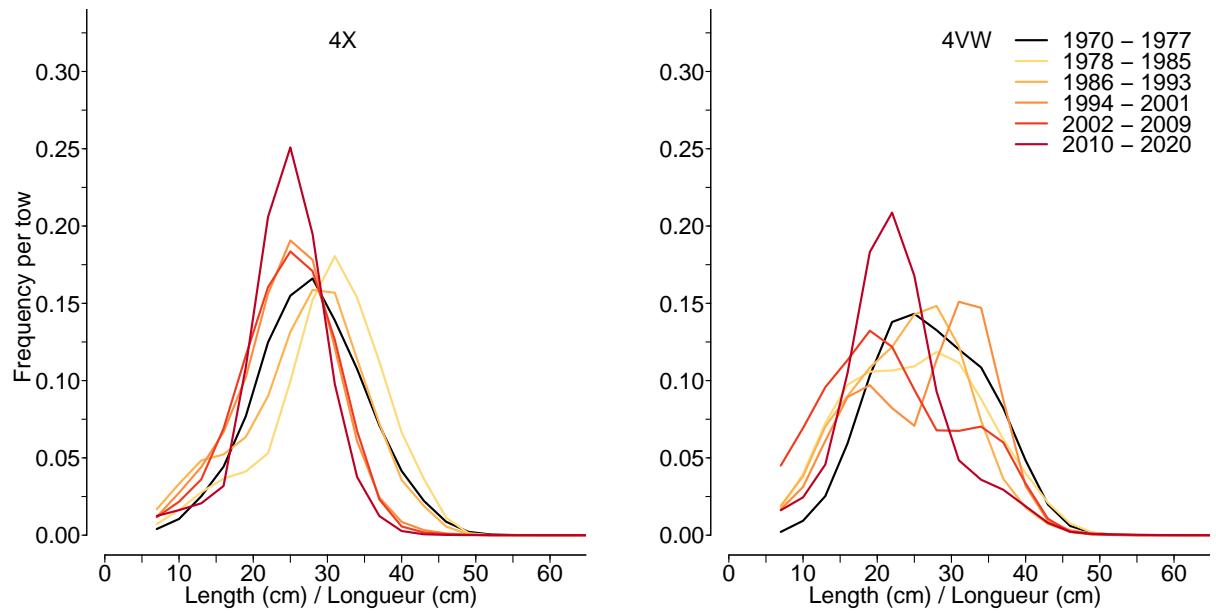


Figure 7.7C. Length frequency distribution in NAFO units 4X and 4VW for Atlantic redfishes.

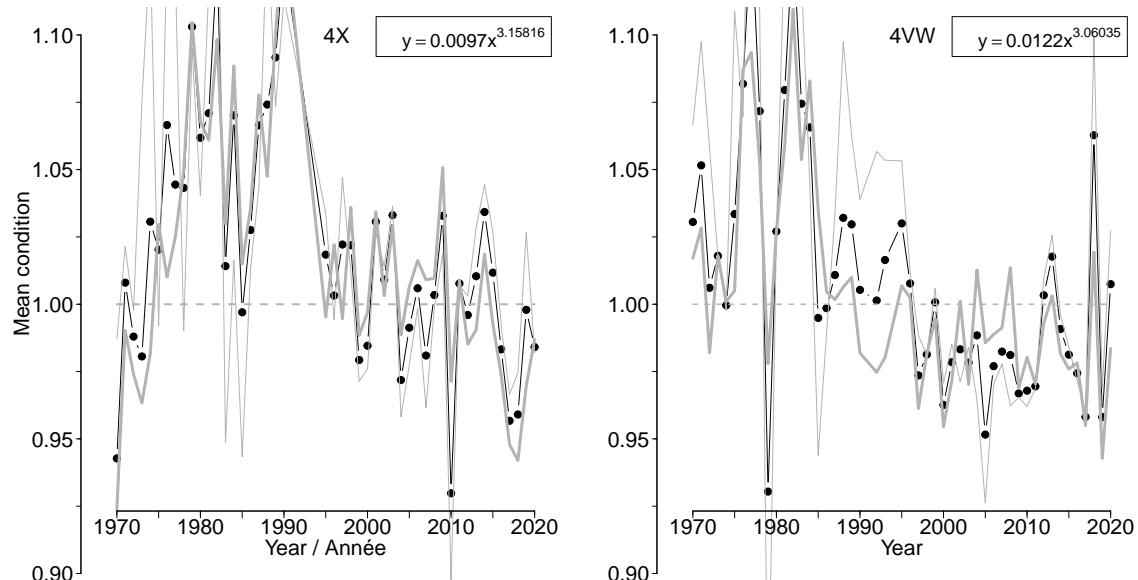


Figure 7.7D. Average fish condition in NAFO units 4X and 4VW for Atlantic redfishes.

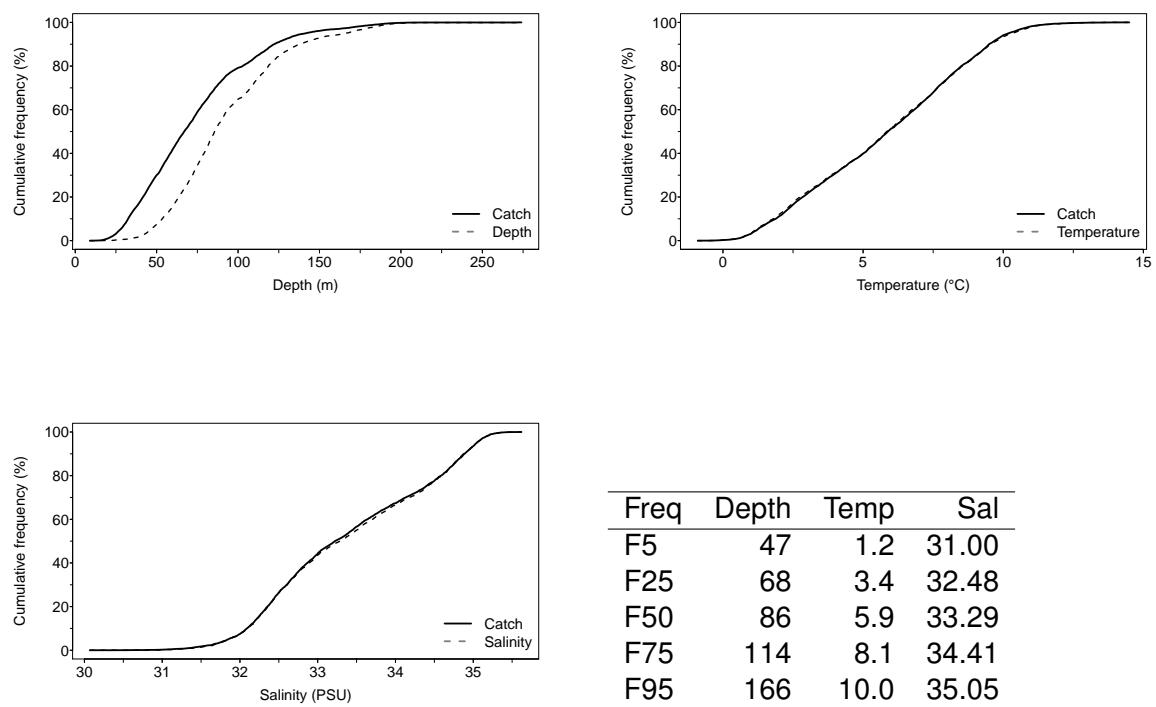


Figure 7.7E. Catch distribution by depth, temperature and salinity of Atlantic redfishes.

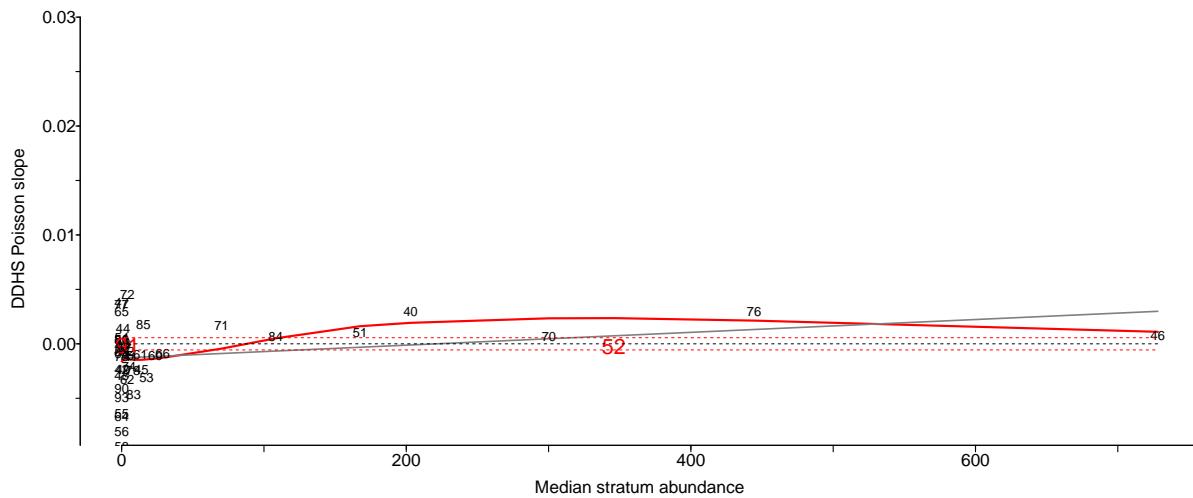


Figure 7.7F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Atlantic redfishes.

7.8 Atlantic halibut (Flétan de l'Atlantique) - species code 30 (category LF)

Scientific name: [Hippoglossus hippoglossus](#)

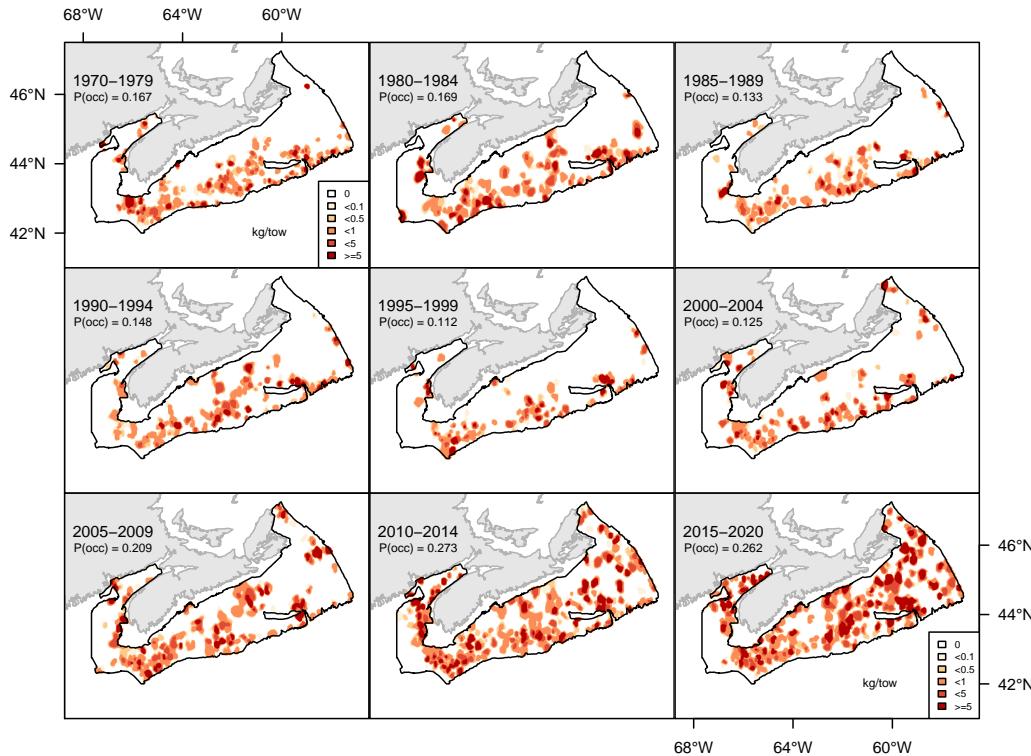


Figure 7.8A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic halibut.

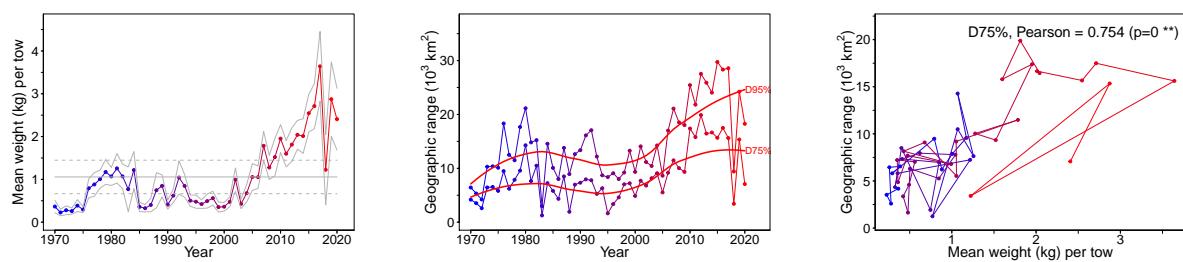


Figure 7.8B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic halibut.

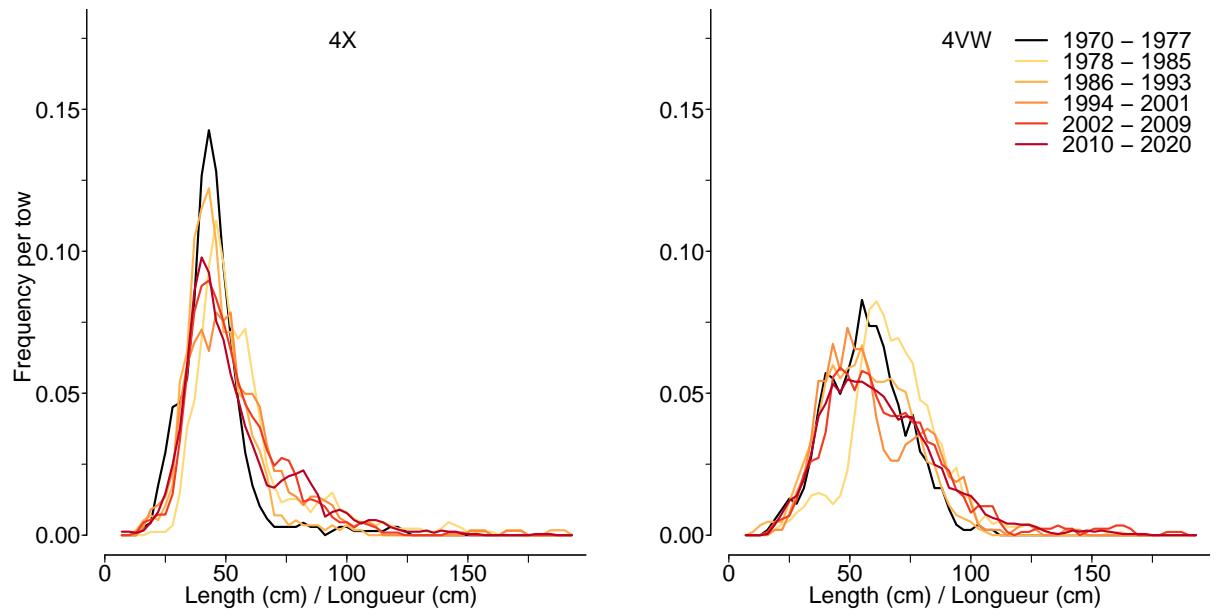


Figure 7.8C. Length frequency distribution in NAFO units 4X and 4VW for Atlantic halibut.

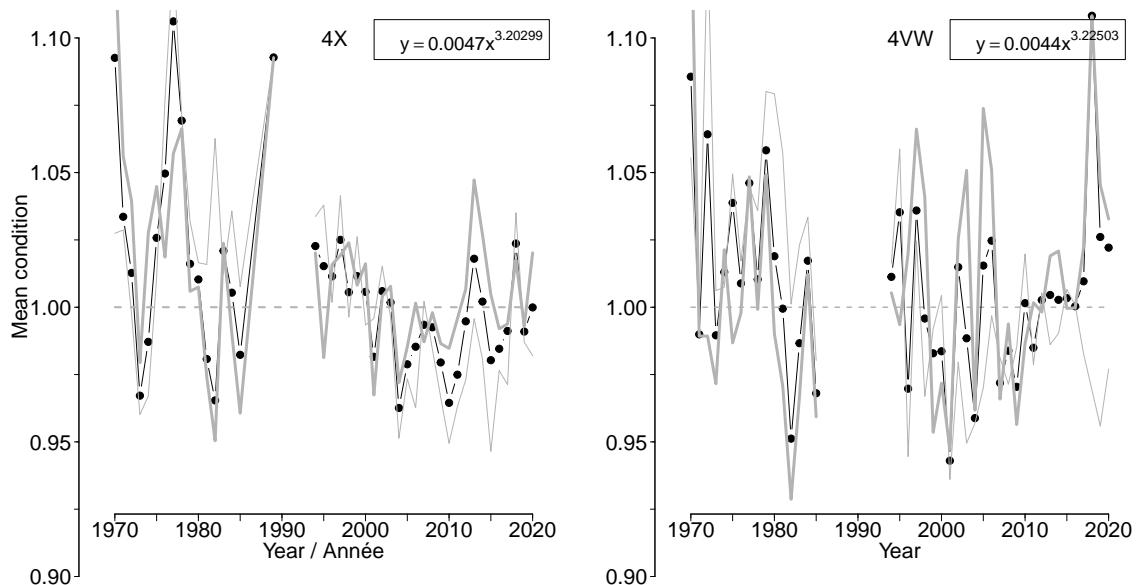
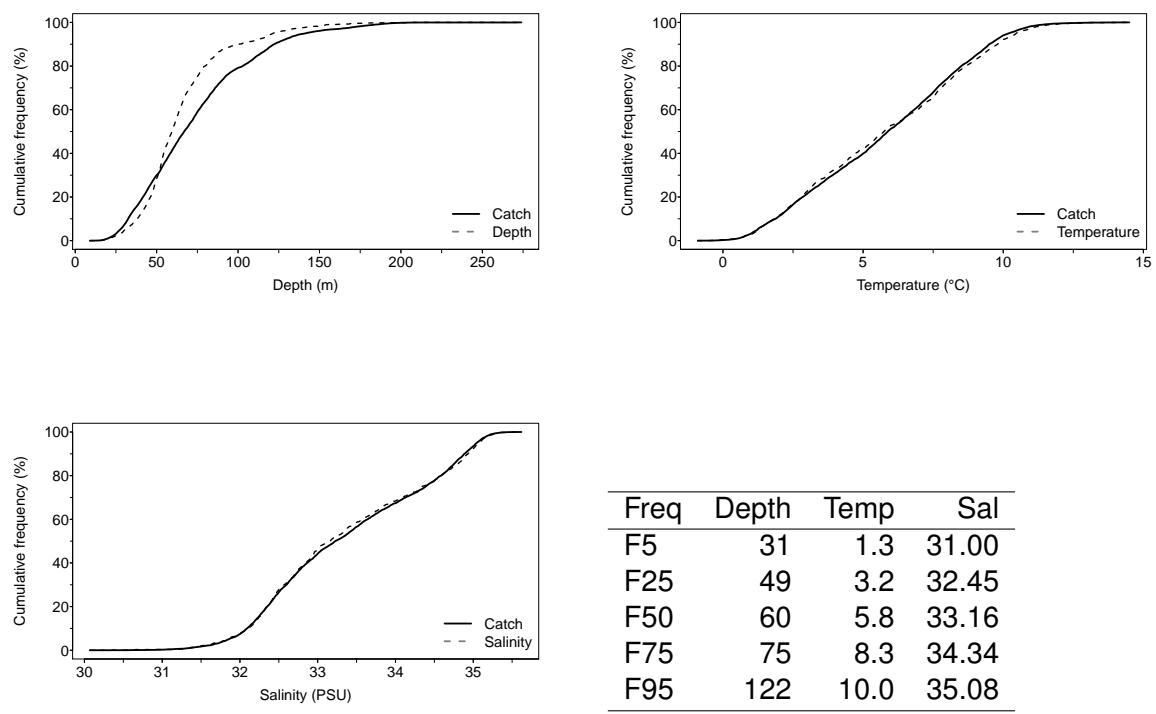


Figure 7.8D. Average fish condition in NAFO units 4X and 4VW for Atlantic halibut.



Freq	Depth	Temp	Sal
F5	31	1.3	31.00
F25	49	3.2	32.45
F50	60	5.8	33.16
F75	75	8.3	34.34
F95	122	10.0	35.08

Figure 7.8E. Catch distribution by depth, temperature and salinity of Atlantic halibut.

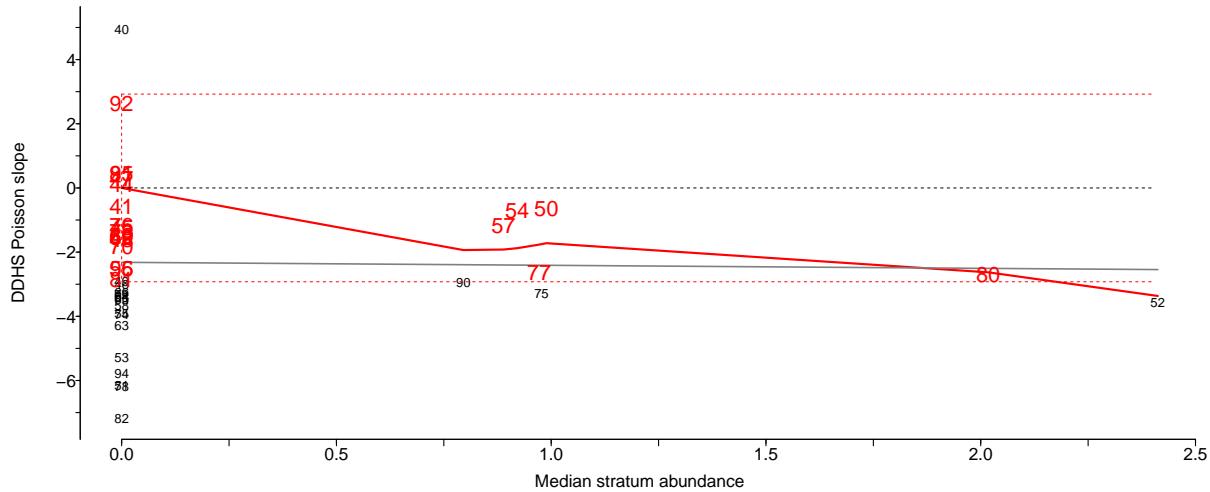


Figure 7.8F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Atlantic halibut.

7.9 American plaice (*Ple canadienne*) - species code 40 (category LF)

Scientific name: [Hippoglossoides platessoides](#)

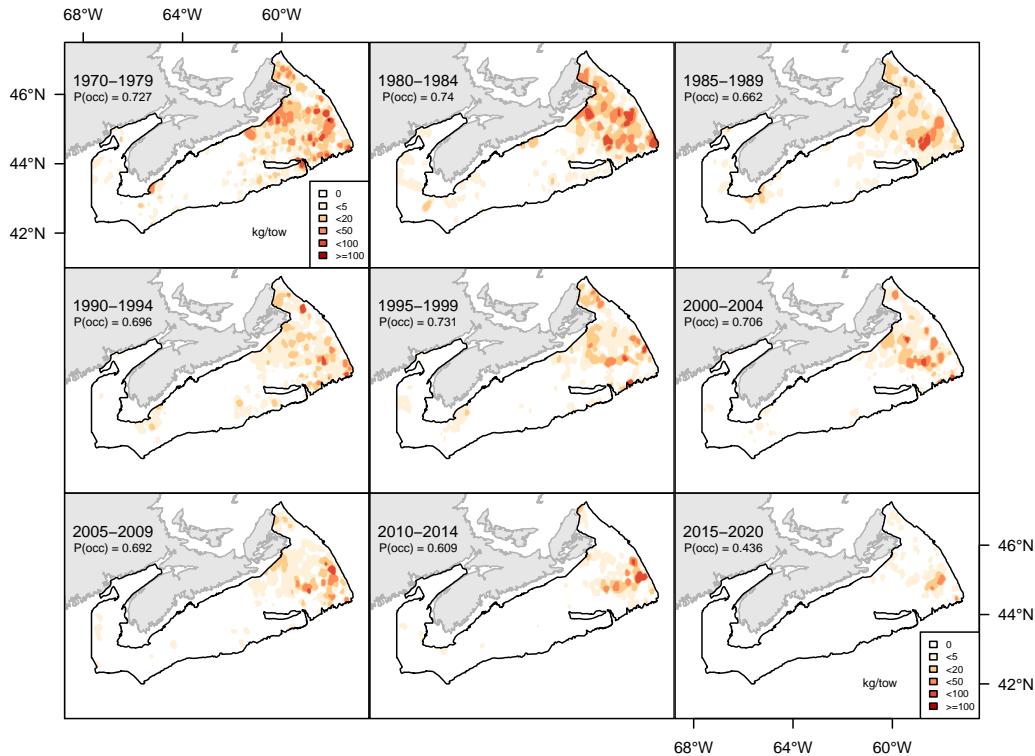


Figure 7.9A. Inverse distance weighted distribution of catch biomass (kg/tow) for American plaice.

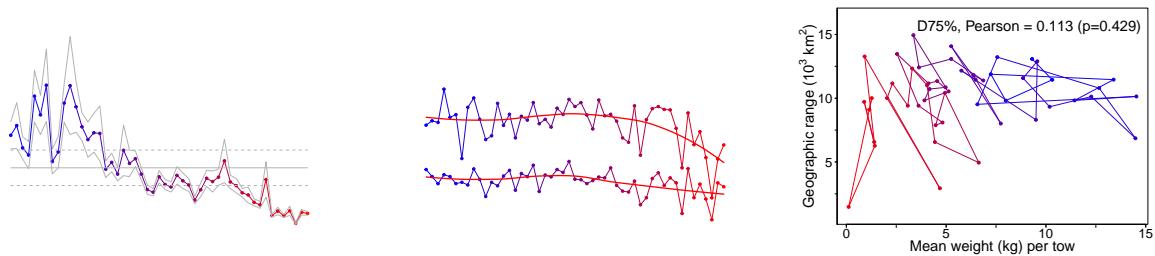


Figure 7.9B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of American plaice.

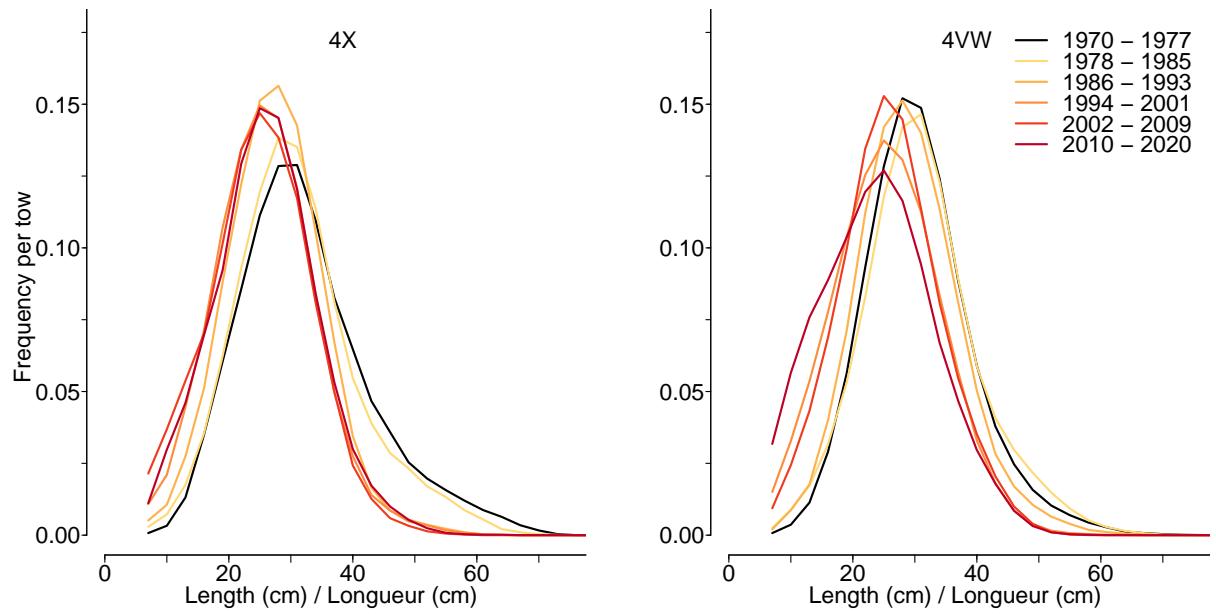


Figure 7.9C. Length frequency distribution in NAFO units 4X and 4VW for American plaice.

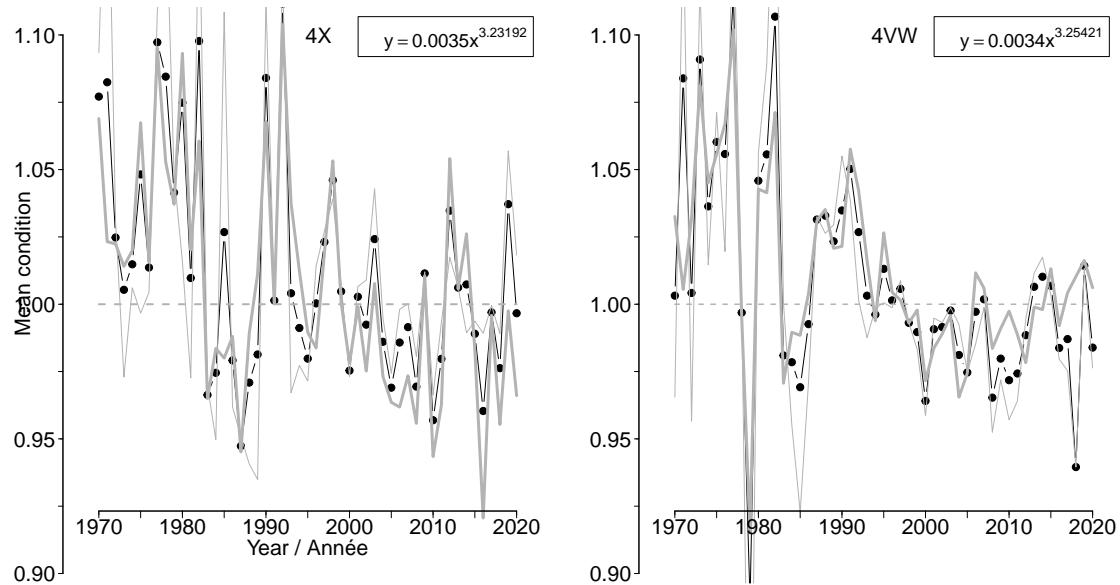


Figure 7.9D. Average fish condition in NAFO units 4X and 4VW for American plaice.

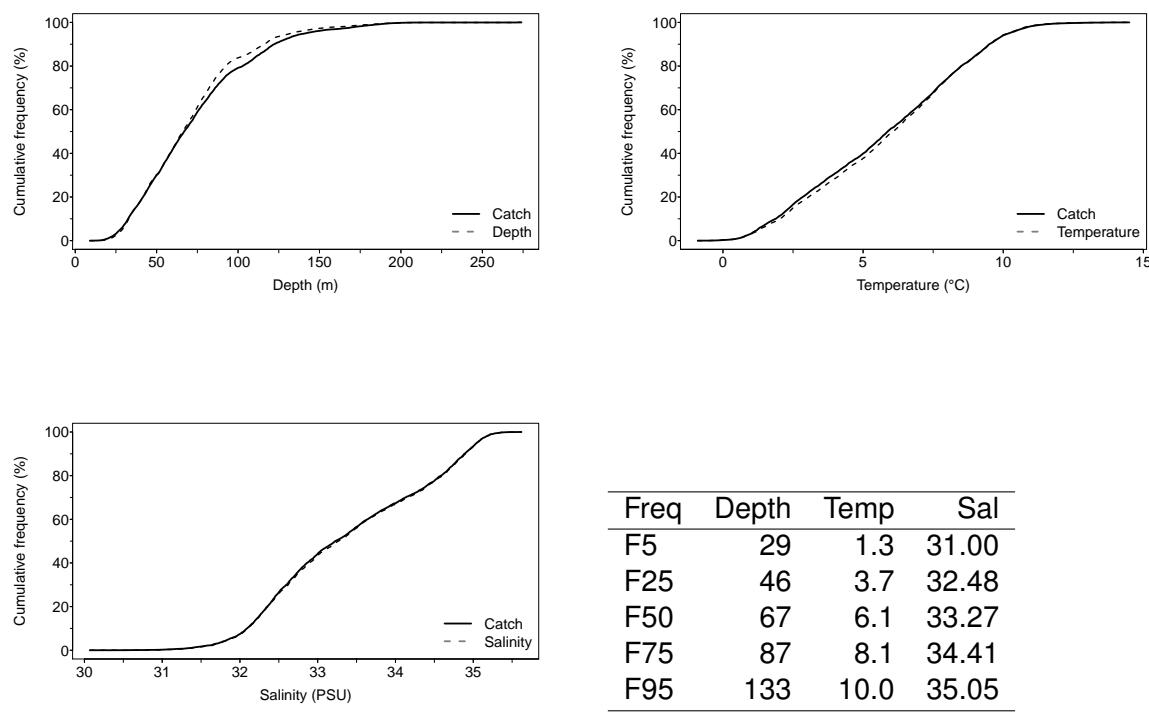


Figure 7.9E. Catch distribution by depth, temperature and salinity of American plaice.

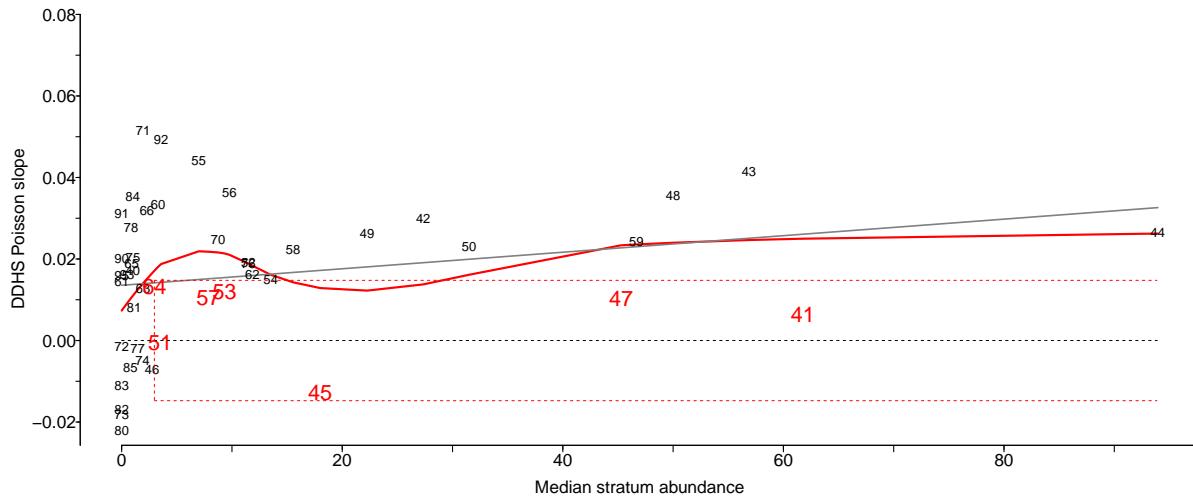


Figure 7.9F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for American plaice.

7.10 Witch flounder (*Ple grise*) - species code 41 (category LF)

Scientific name: [Glyptocephalus cynoglossus](#)

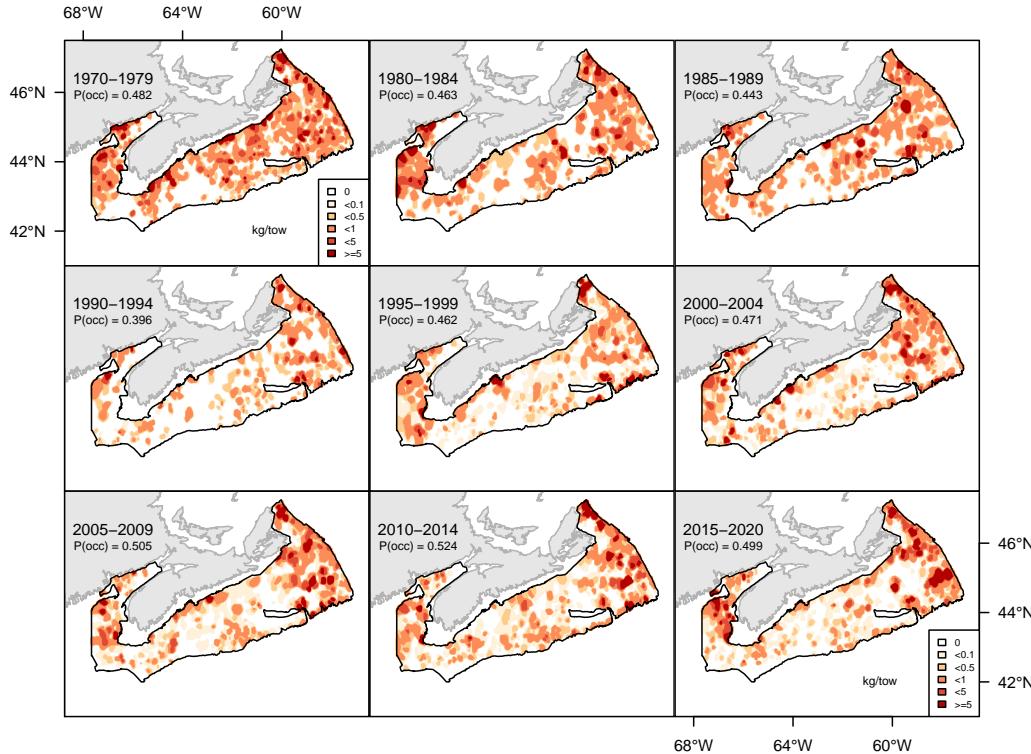


Figure 7.10A. Inverse distance weighted distribution of catch biomass (kg/tow) for Witch flounder.

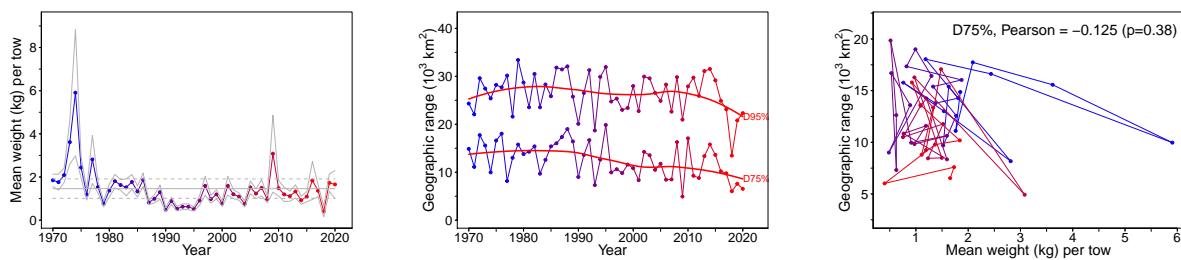


Figure 7.10B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Witch flounder.

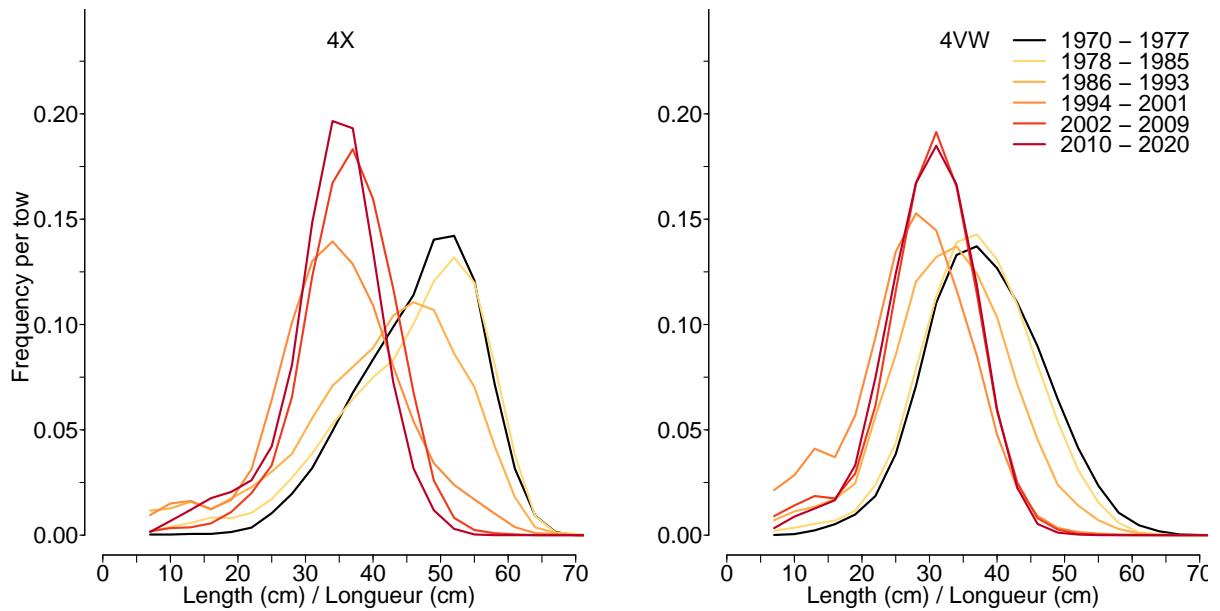


Figure 7.10C. Length frequency distribution in NAFO units 4X and 4VW for Witch flounder.

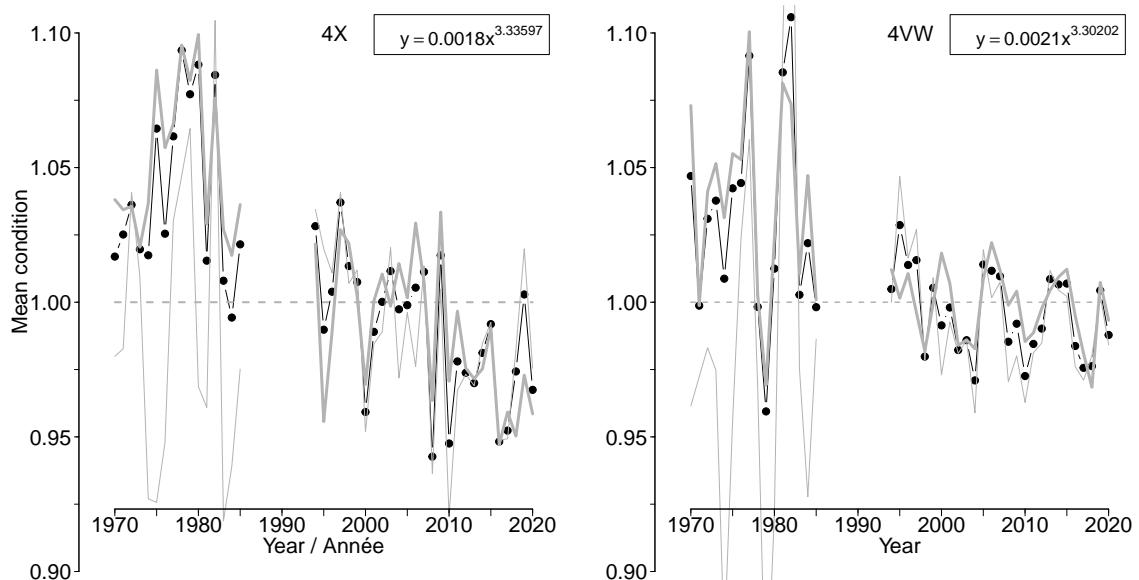


Figure 7.10D. Average fish condition in NAFO units 4X and 4VW for Witch flounder.

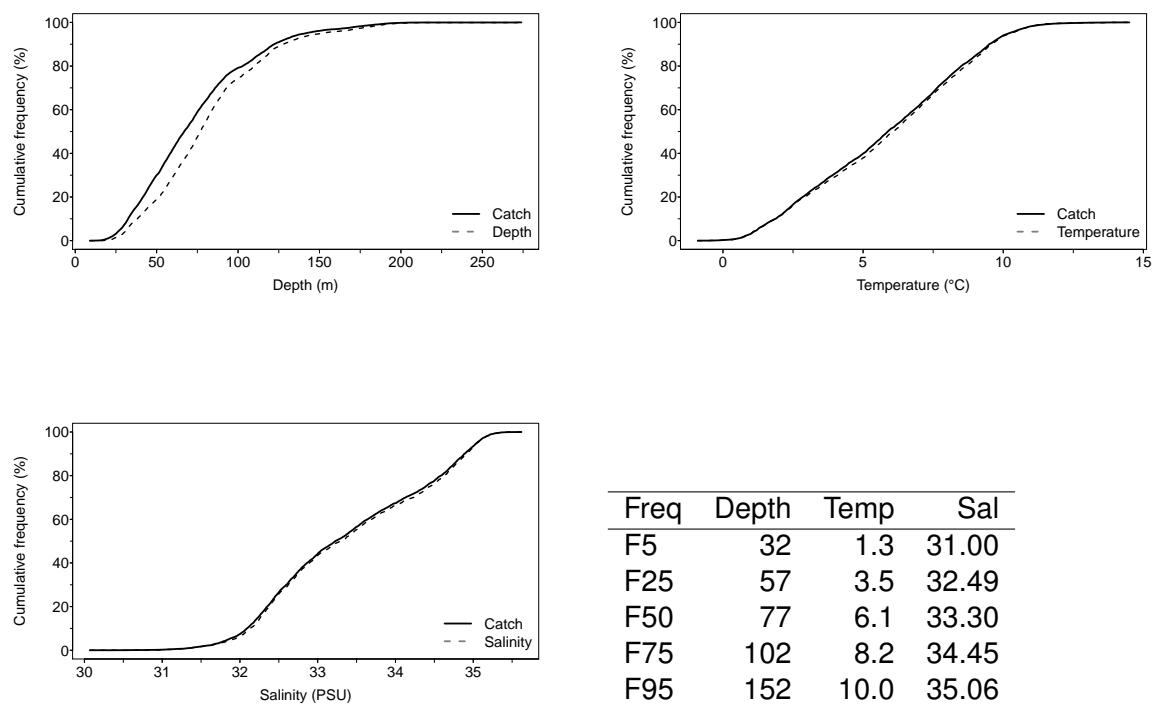


Figure 7.10E. Catch distribution by depth, temperature and salinity of Witch flounder.

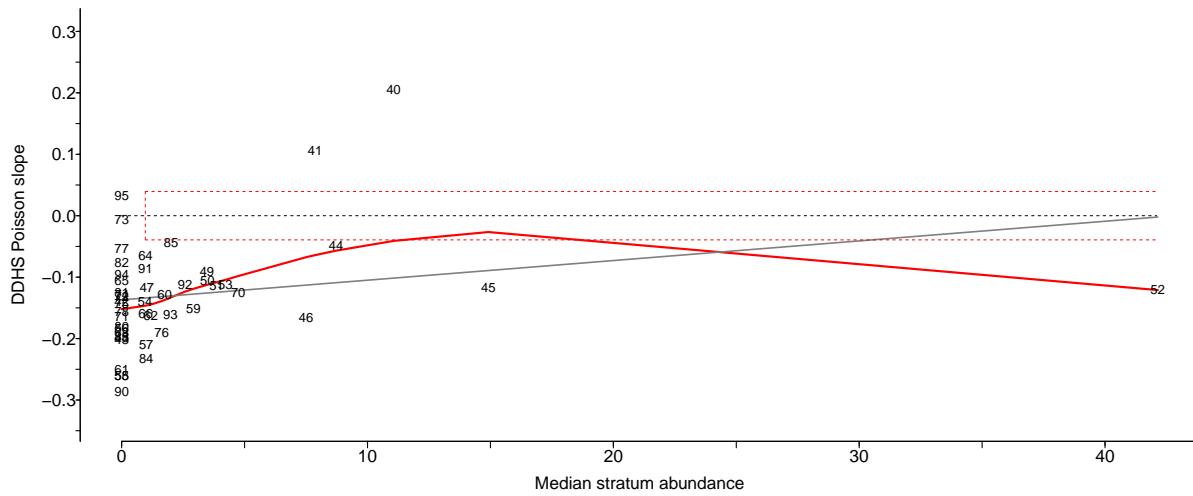


Figure 7.10F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Witch flounder.

7.11 Yellowtail flounder (Limande à queue jaune) - species code 42 (category LF)

Scientific name: [Limanda ferruginea](#)

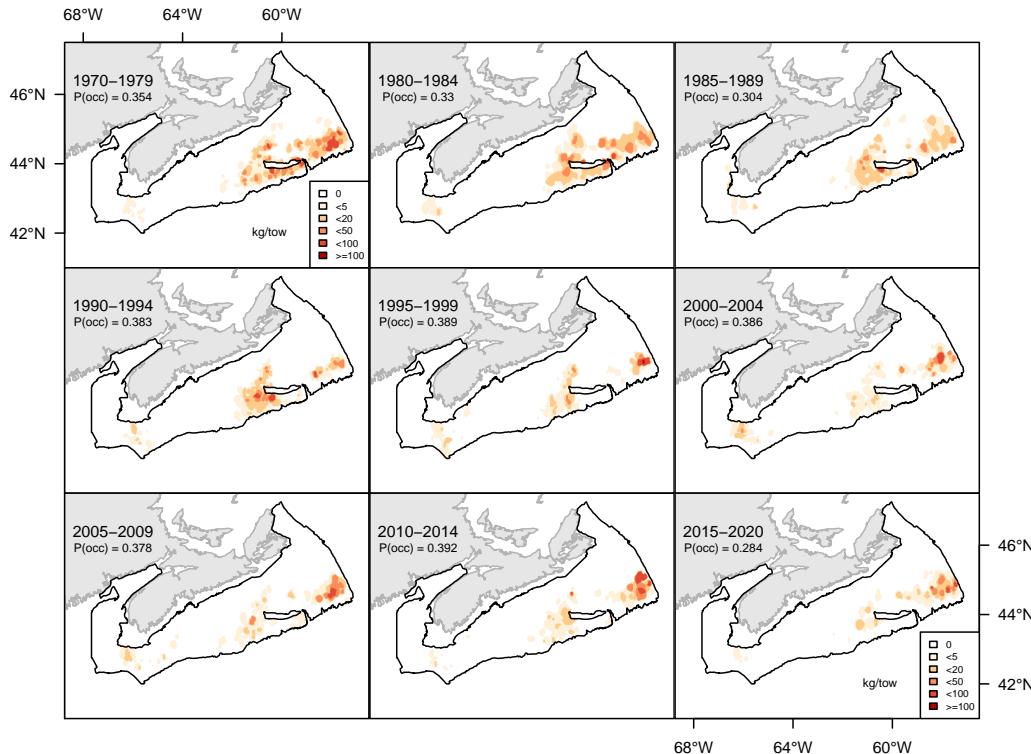


Figure 7.11A. Inverse distance weighted distribution of catch biomass (kg/tow) for Yellowtail flounder.

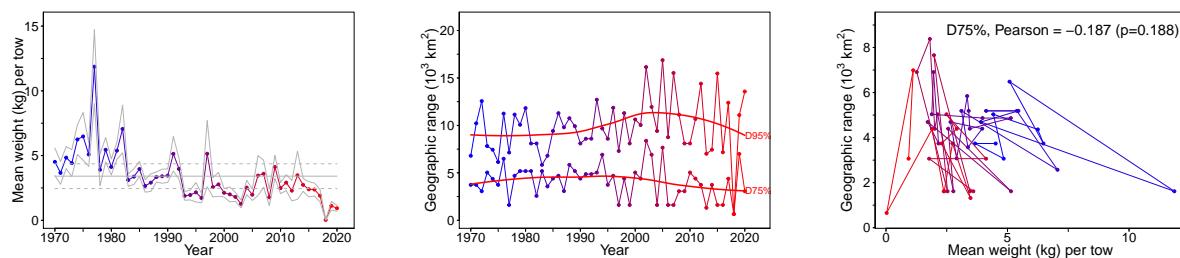


Figure 7.11B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Yellowtail flounder.

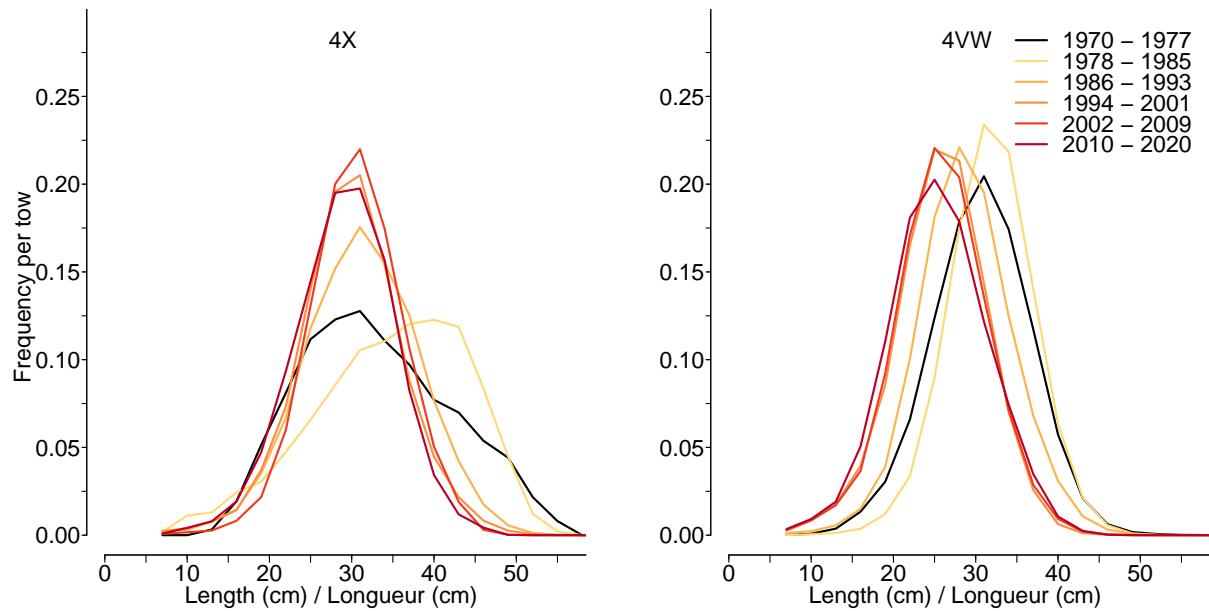


Figure 7.11C. Length frequency distribution in NAFO units 4X and 4VW for Yellowtail flounder.

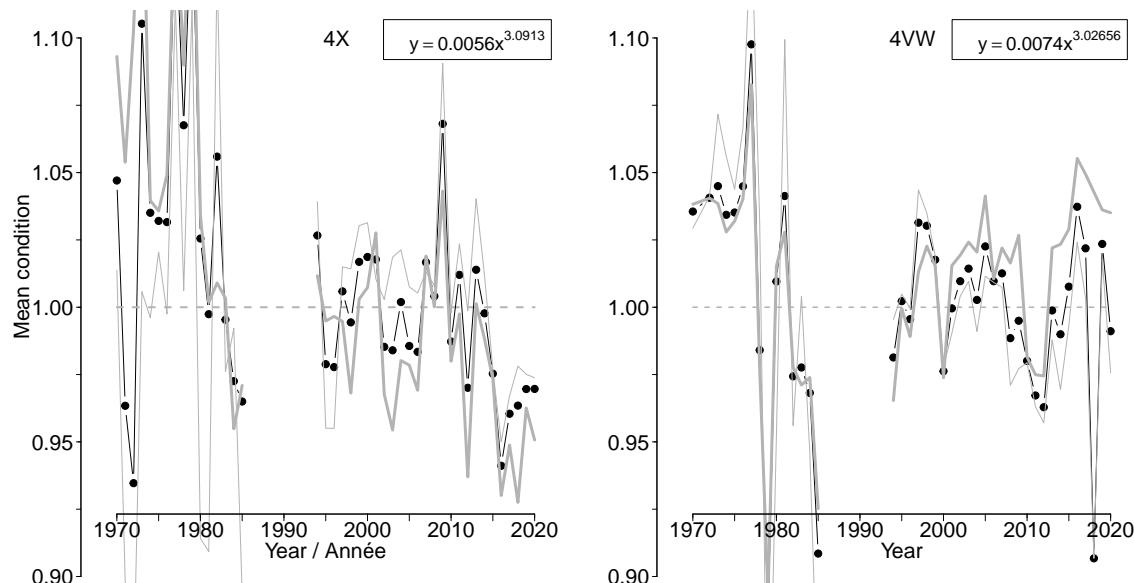


Figure 7.11D. Average fish condition in NAFO units 4X and 4VW for Yellowtail flounder.

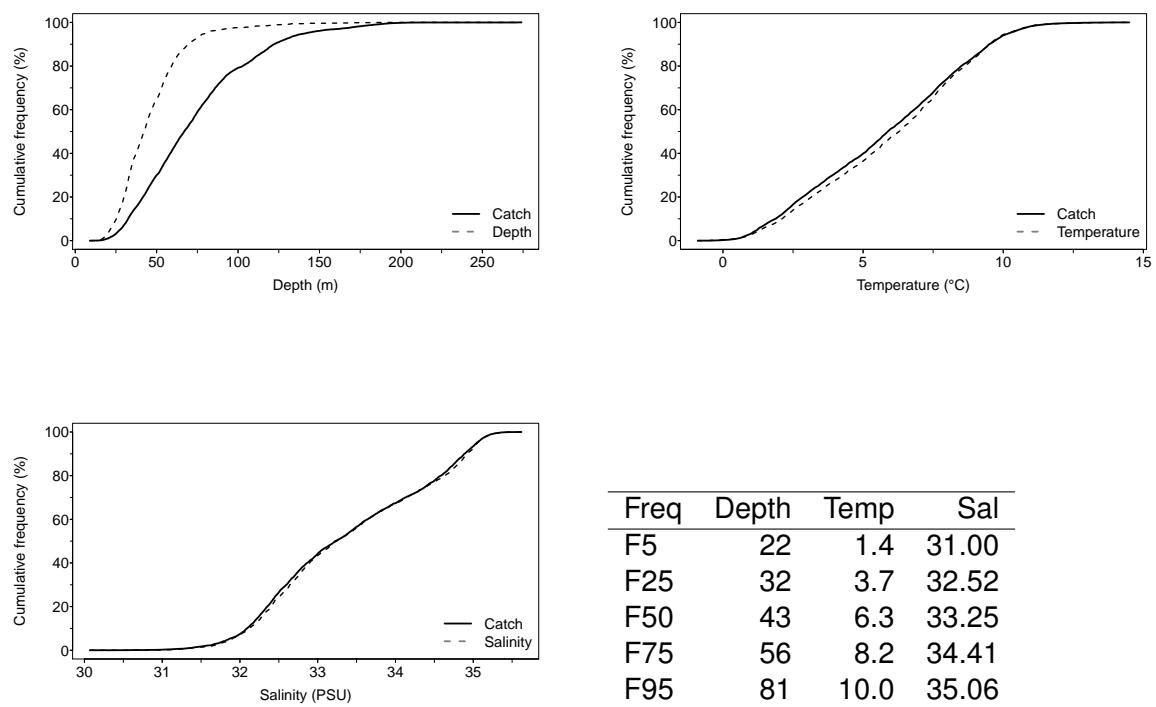


Figure 7.11E. Catch distribution by depth, temperature and salinity of Yellowtail flounder.

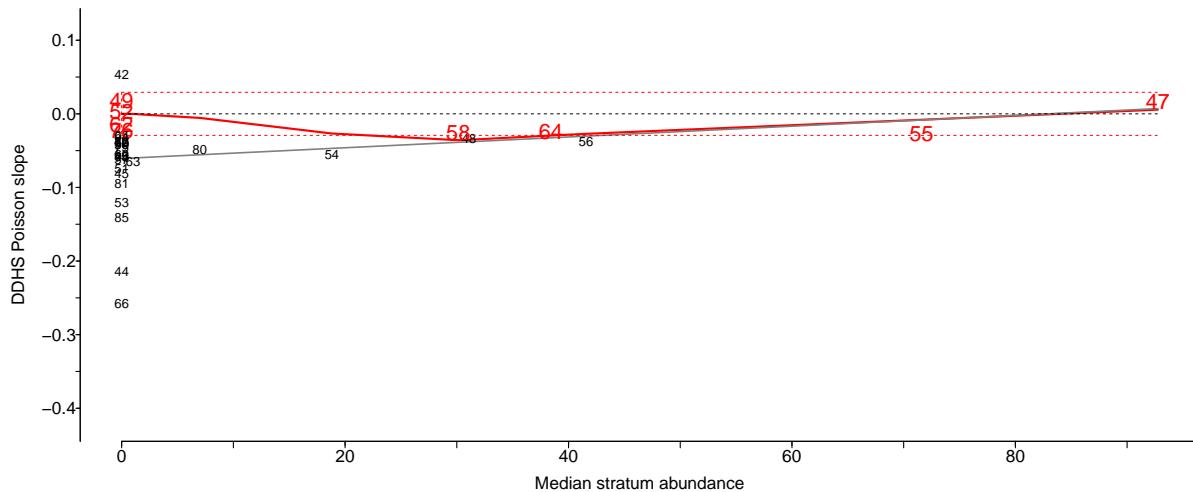


Figure 7.11F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Yellowtail flounder.

7.12 Winter flounder (Limande-plie rouge) - species code 43 (category LF)

Scientific name: [Pseudopleuronectes americanus](#)

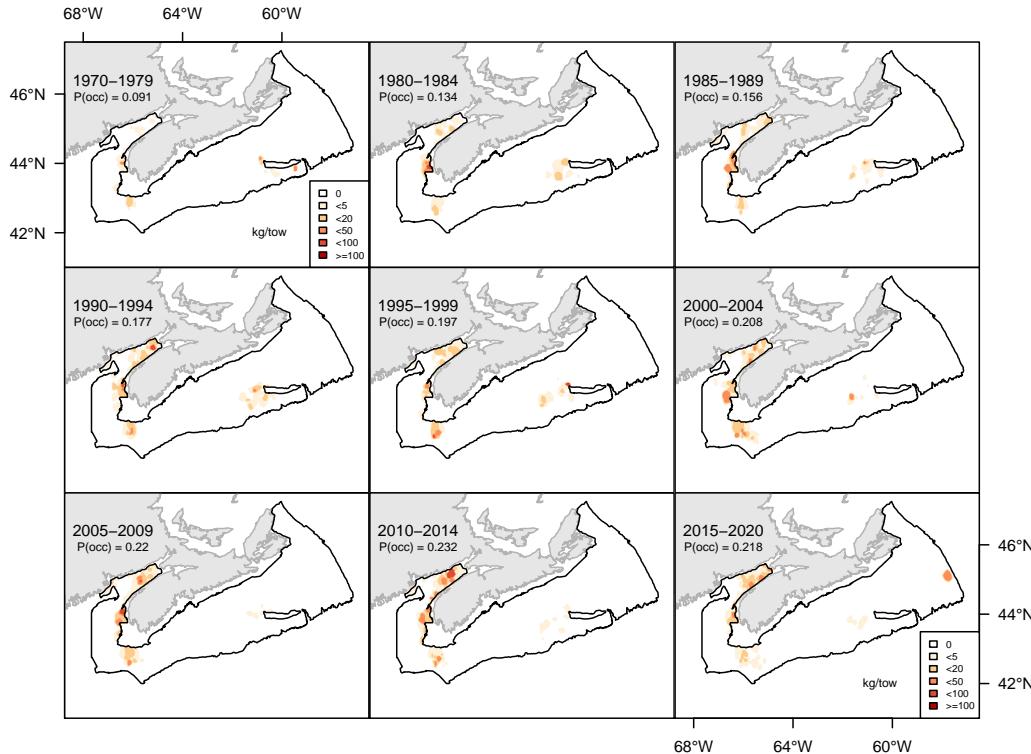


Figure 7.12A. Inverse distance weighted distribution of catch biomass (kg/tow) for Winter flounder.

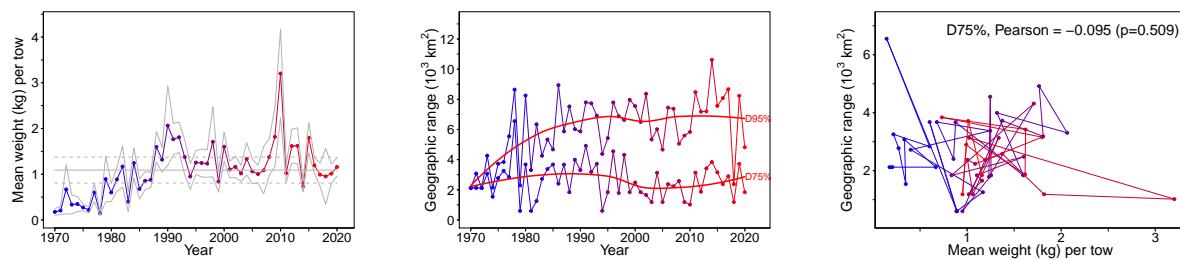


Figure 7.12B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Winter flounder.

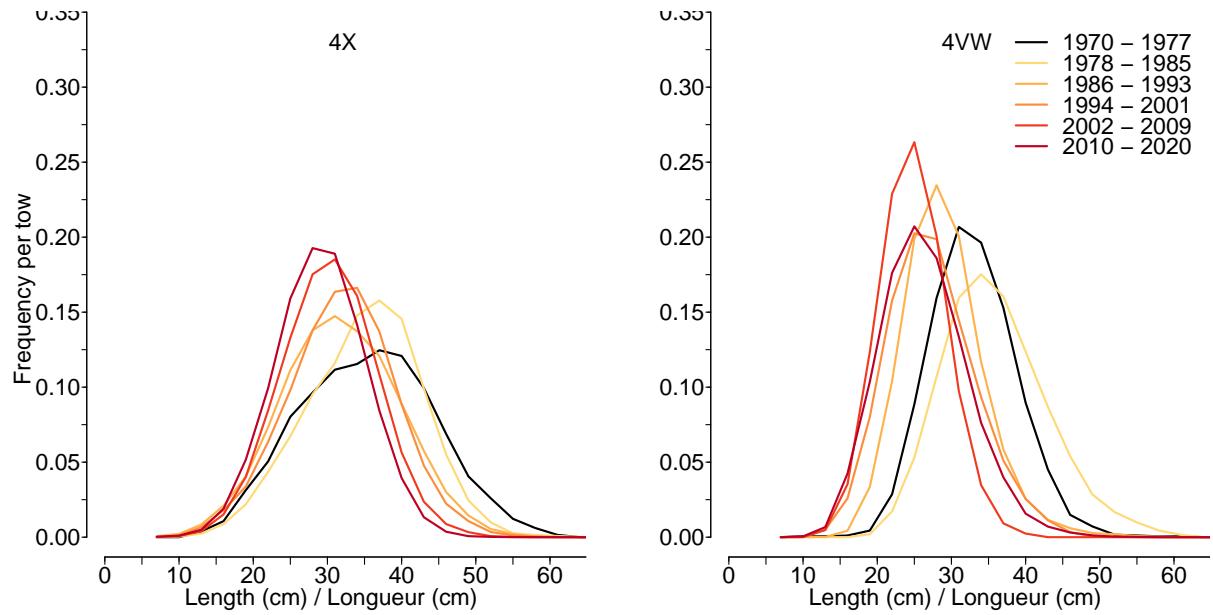


Figure 7.12C. Length frequency distribution in NAFO units 4X and 4VW for Winter flounder.

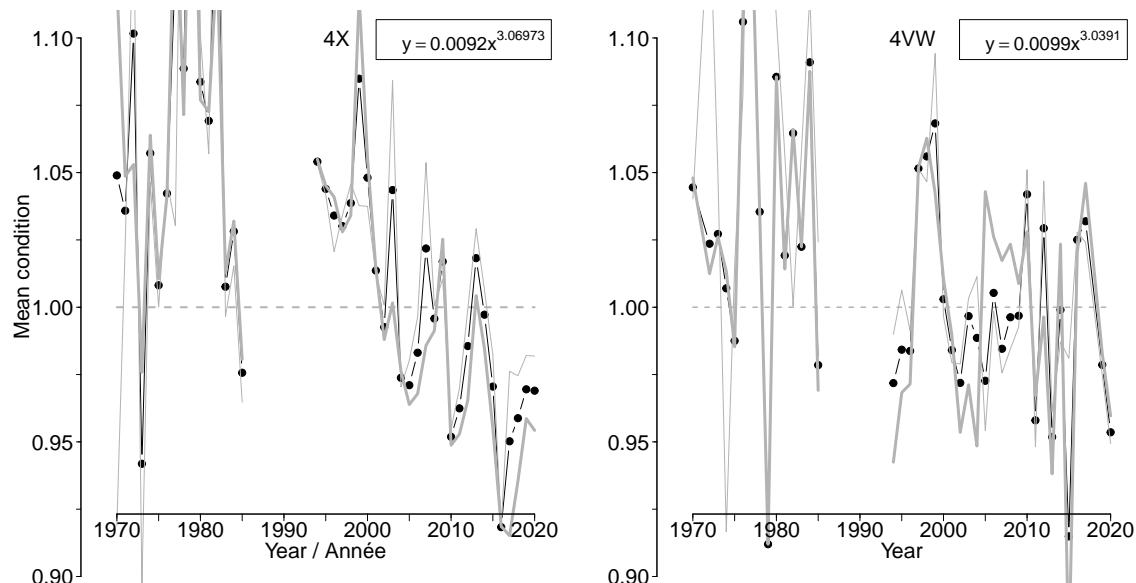
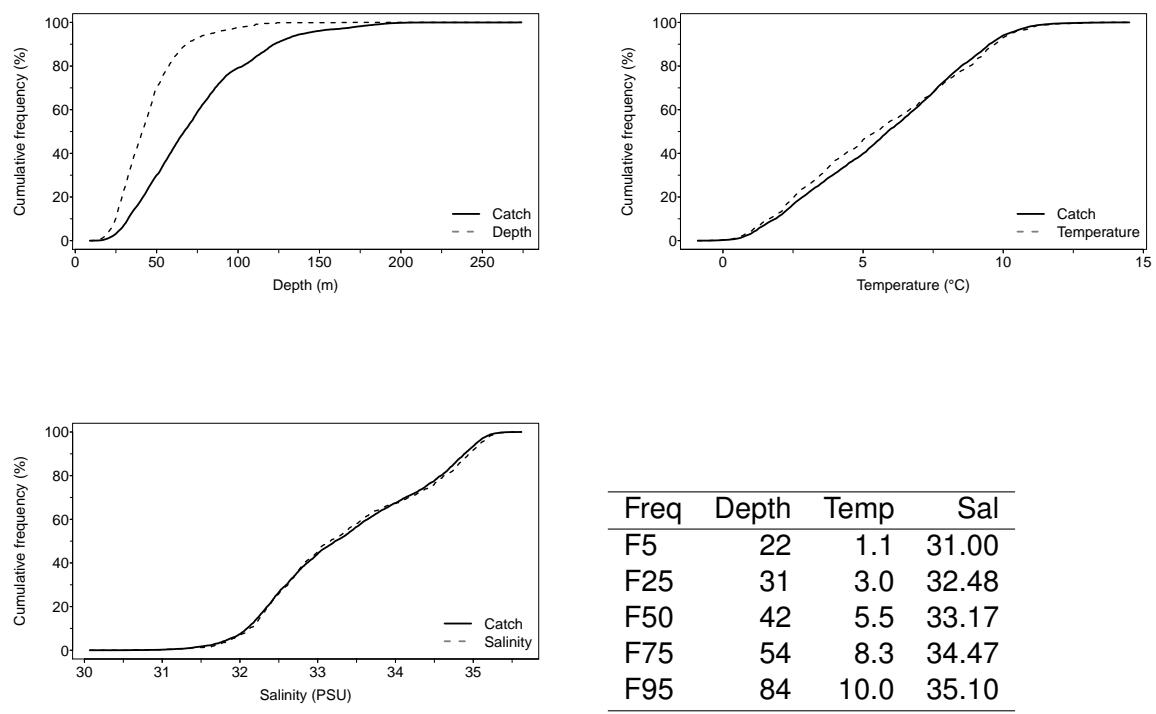


Figure 7.12D. Average fish condition in NAFO units 4X and 4VW for Winter flounder.



Freq	Depth	Temp	Sal
F5	22	1.1	31.00
F25	31	3.0	32.48
F50	42	5.5	33.17
F75	54	8.3	34.47
F95	84	10.0	35.10

Figure 7.12E. Catch distribution by depth, temperature and salinity of Winter flounder.

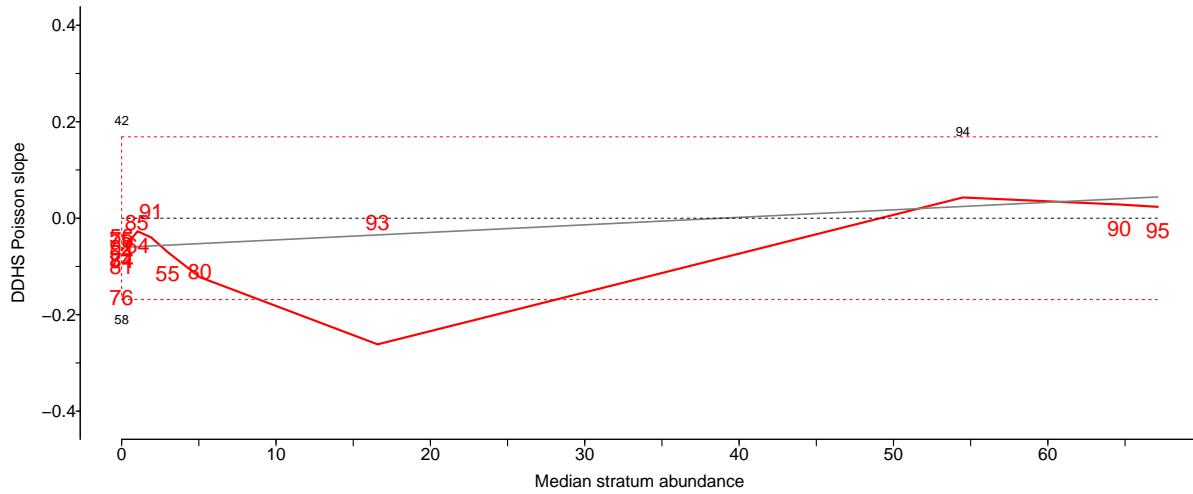


Figure 7.12F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Winter flounder.

7.13 Atlantic wolffish (Loup atlantique) - species code 50 (category LF)

Scientific name: [Anarhichas lupus](#)

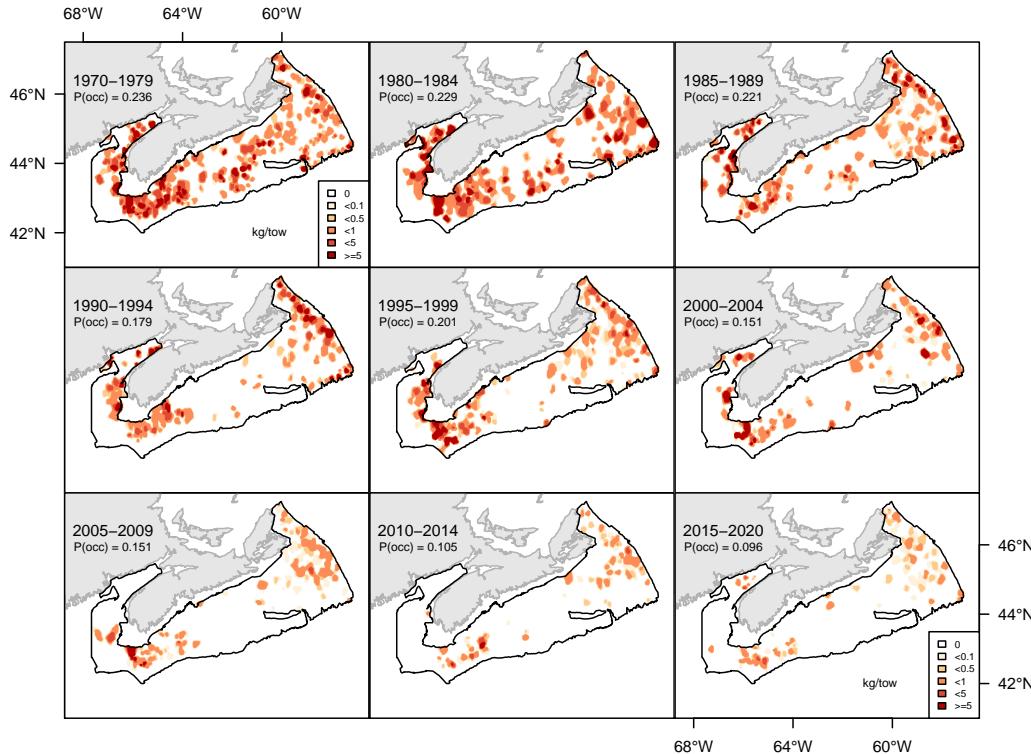


Figure 7.13A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic wolffish.

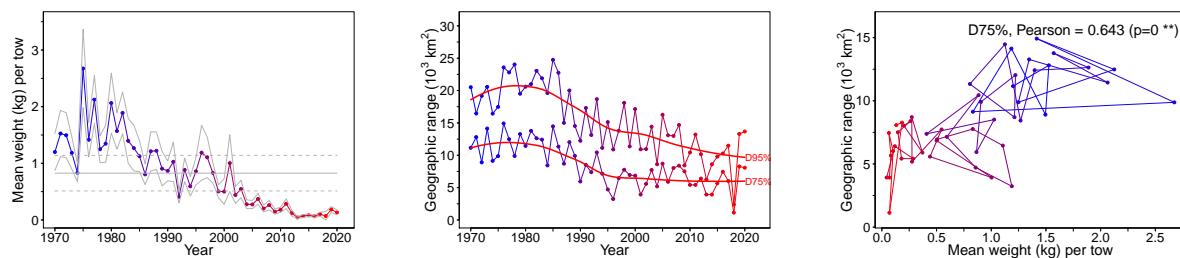


Figure 7.13B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic wolffish.

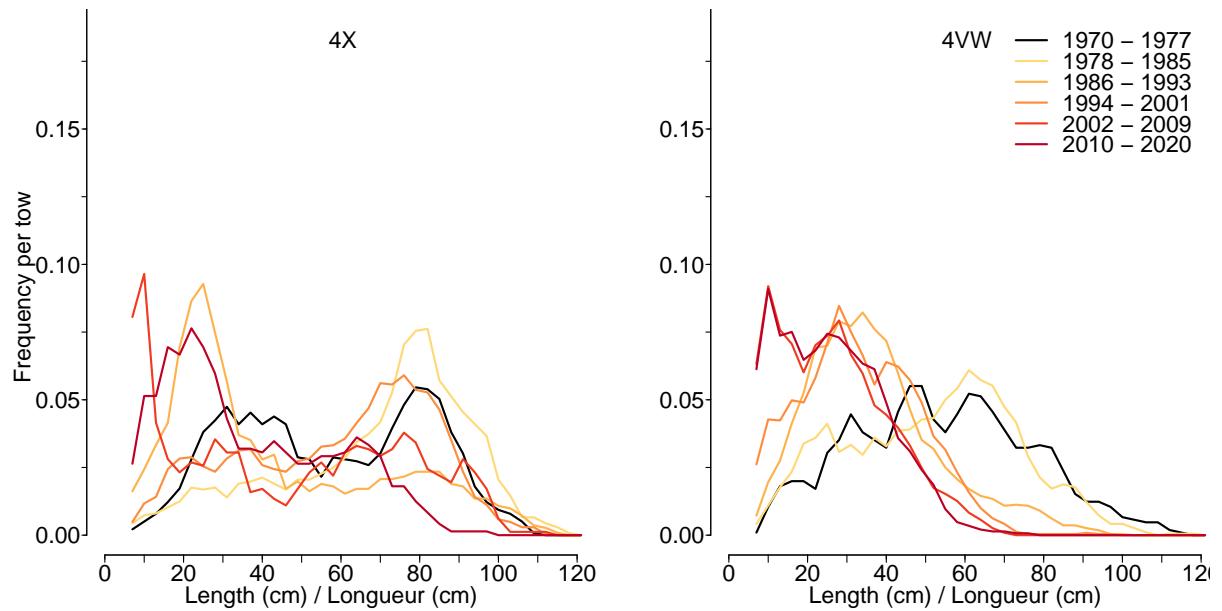


Figure 7.13C. Length frequency distribution in NAFO units 4X and 4VW for Atlantic wolffish.

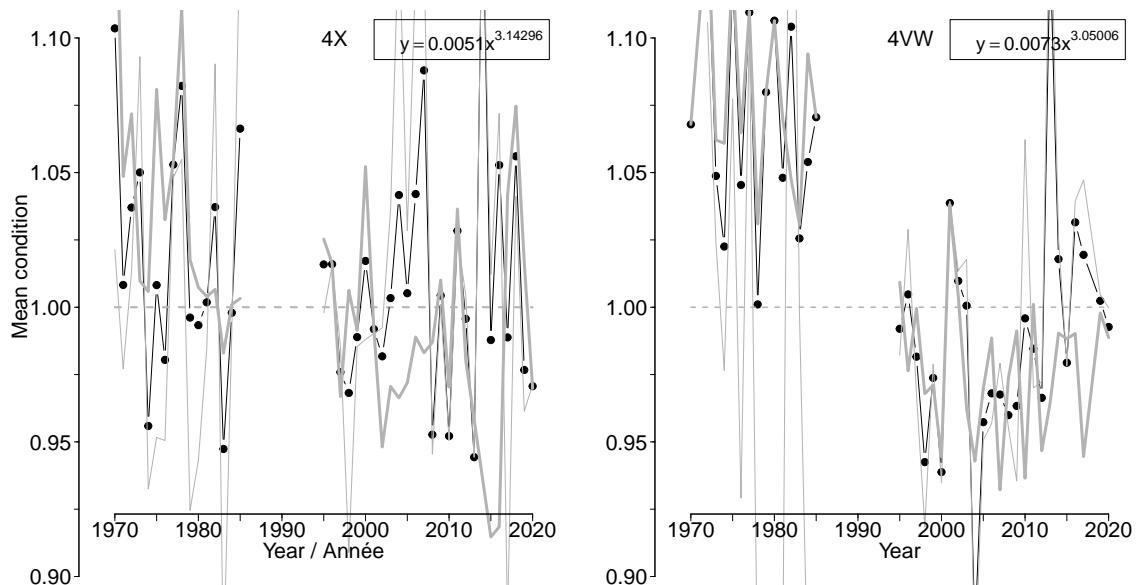


Figure 7.13D. Average fish condition in NAFO units 4X and 4VW for Atlantic wolffish.

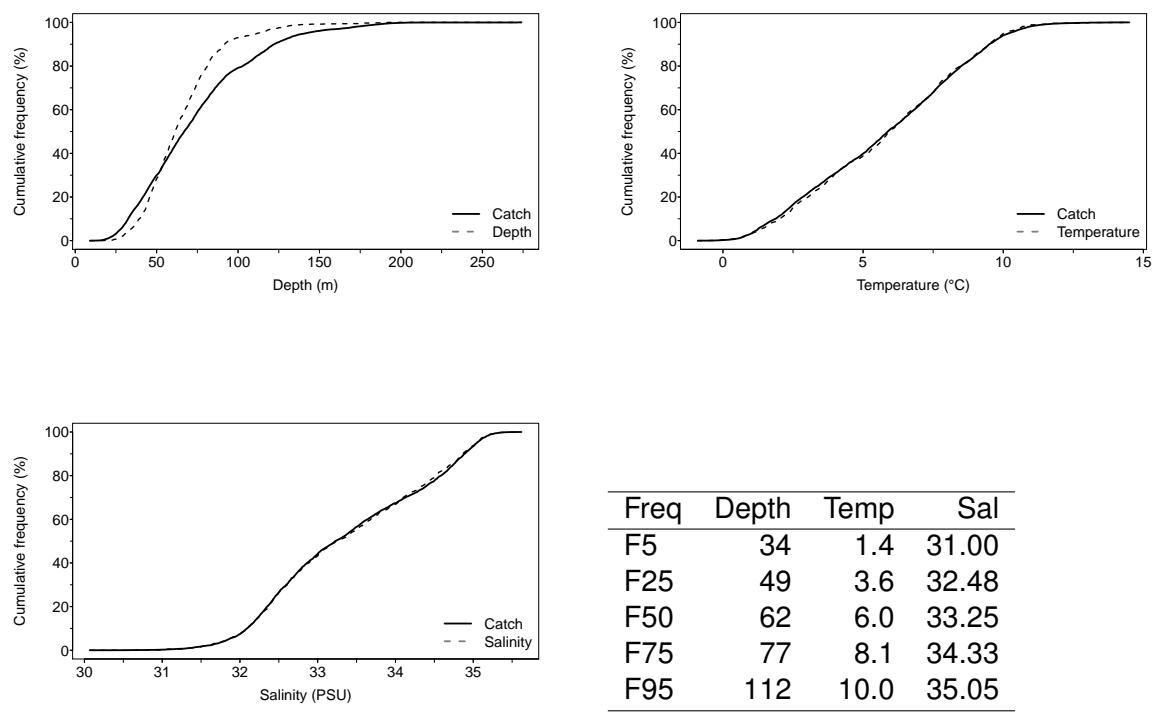


Figure 7.13E. Catch distribution by depth, temperature and salinity of Atlantic wolffish.

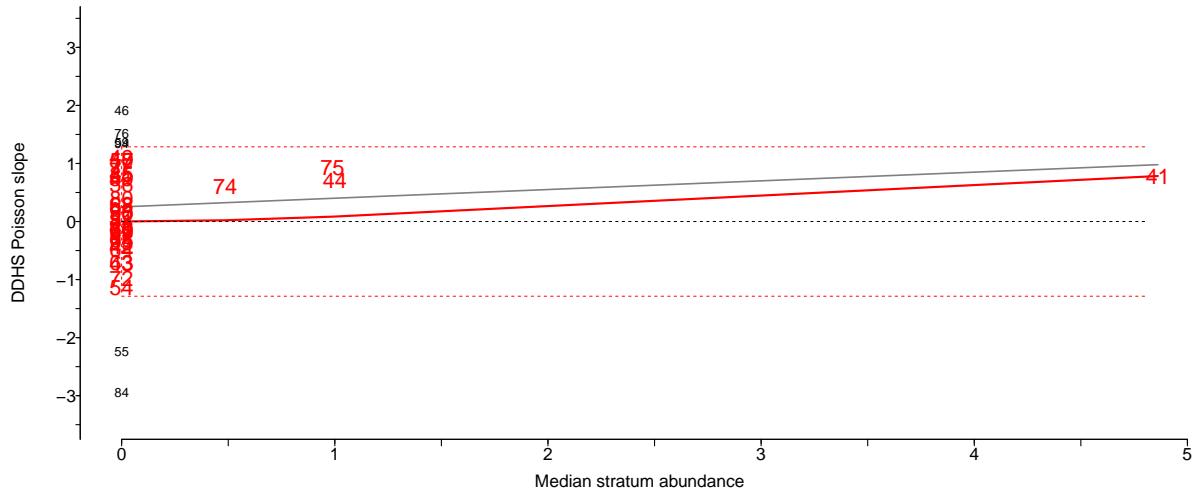


Figure 7.13F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Atlantic wolffish.

7.14 Atlantic herring (Hareng de l'Atlantique) - species code 60 (category LF)

Scientific name: [Clupea harengus](#)

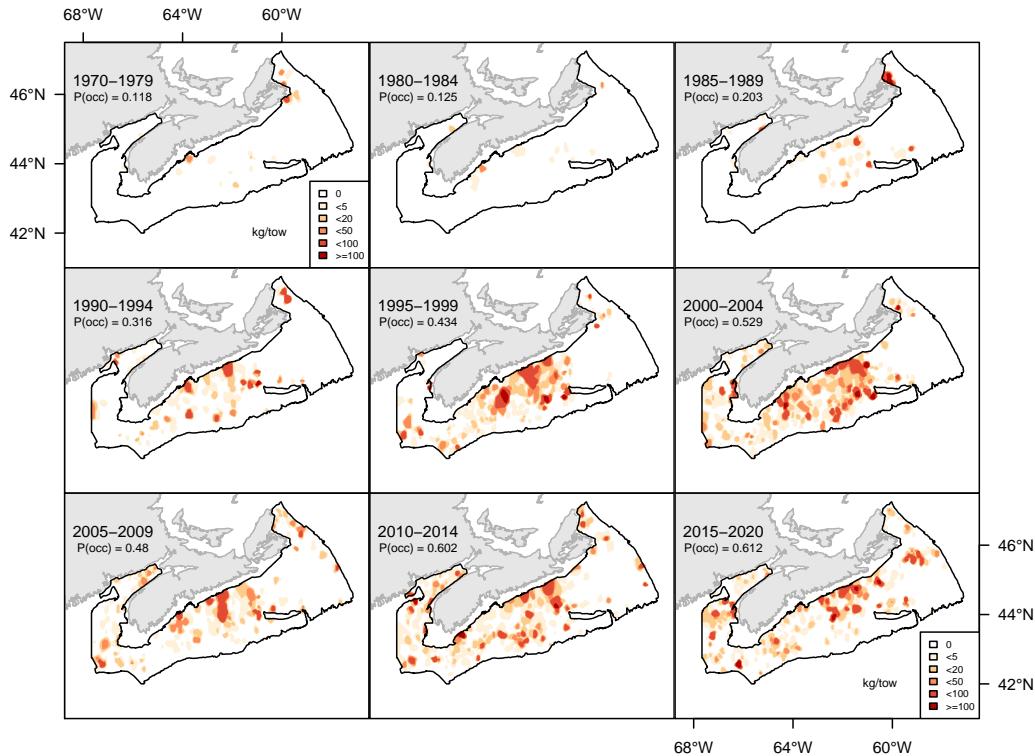


Figure 7.14A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic herring.

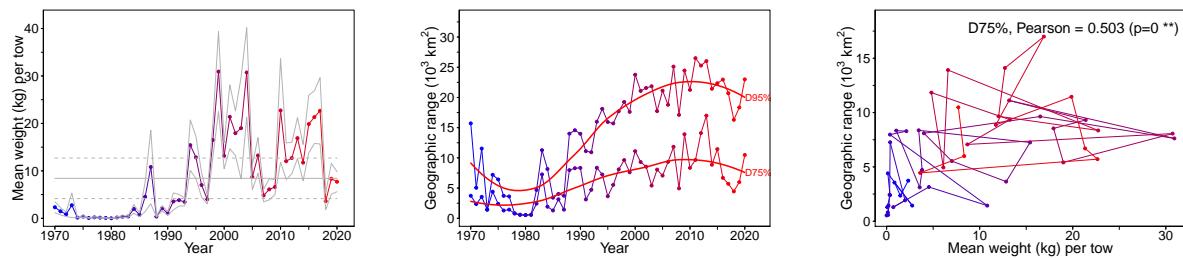


Figure 7.14B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic herring.

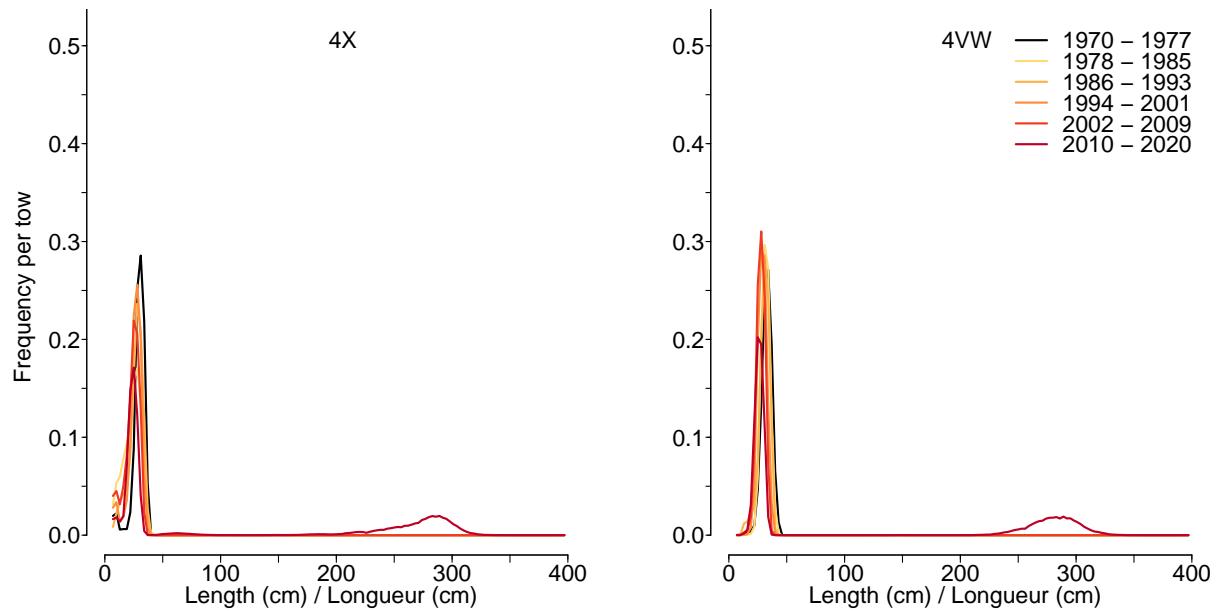


Figure 7.14C. Length frequency distribution in NAFO units 4X and 4VW for Atlantic herring.

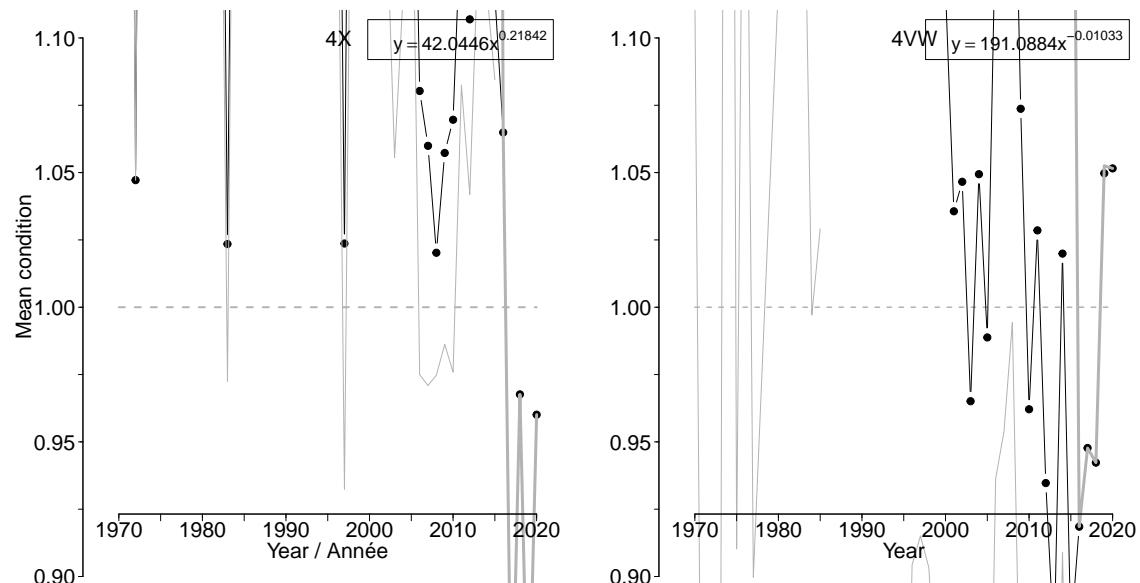


Figure 7.14D. Average fish condition in NAFO units 4X and 4VW for Atlantic herring.

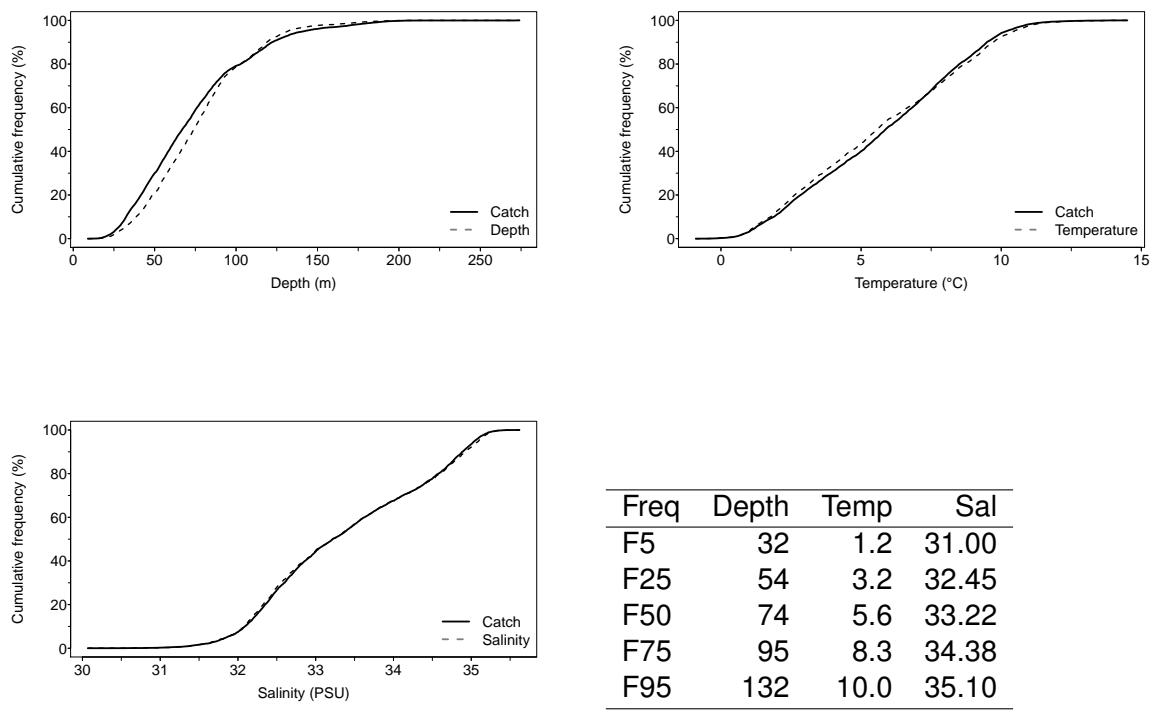


Figure 7.14E. Catch distribution by depth, temperature and salinity of Atlantic herring.

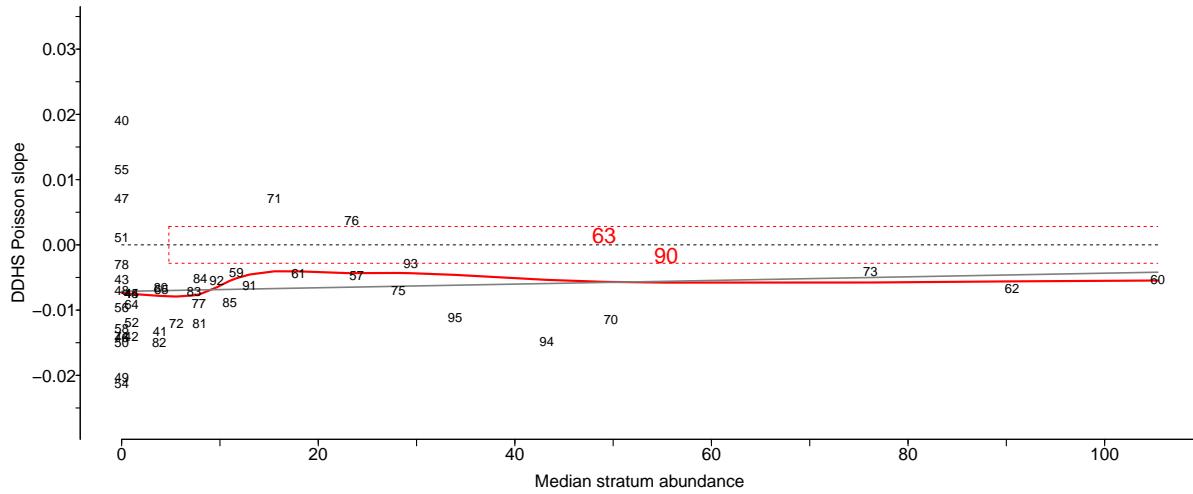


Figure 7.14F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Atlantic herring.

7.15 Longhorn sculpin (Chaboisseau à dix-huit épines) - species code 300 (category LF)

Scientific name: [Myoxocephalus octodecemspiniferus](#)

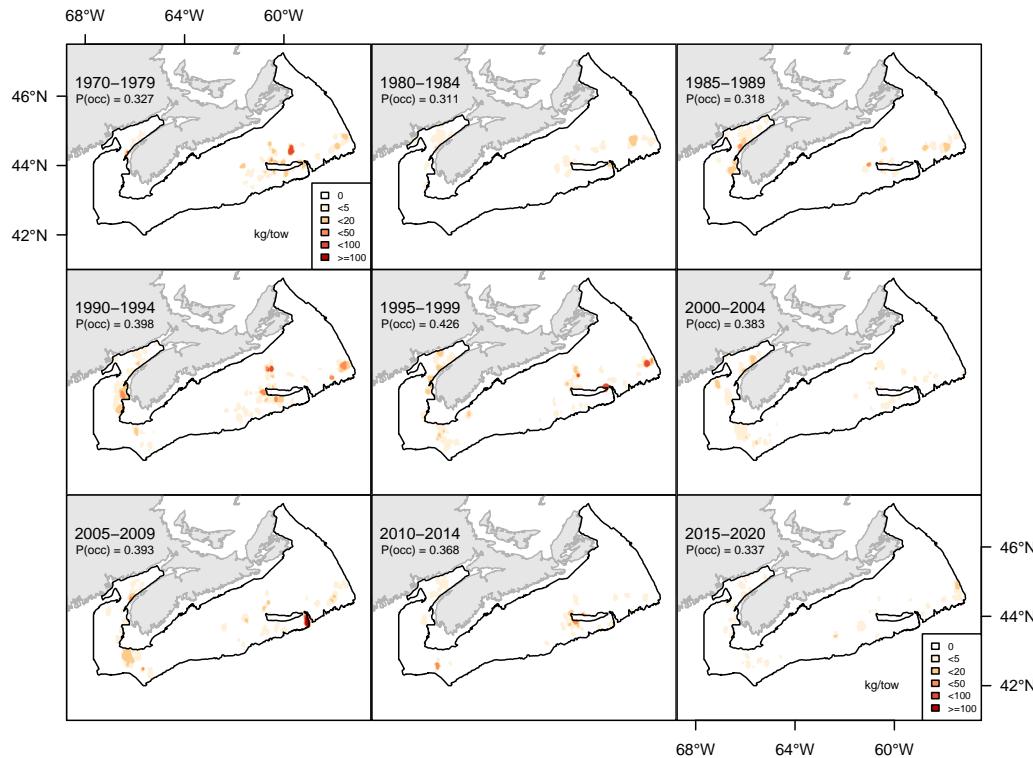


Figure 7.15A. Inverse distance weighted distribution of catch biomass (kg/tow) for Longhorn sculpin.

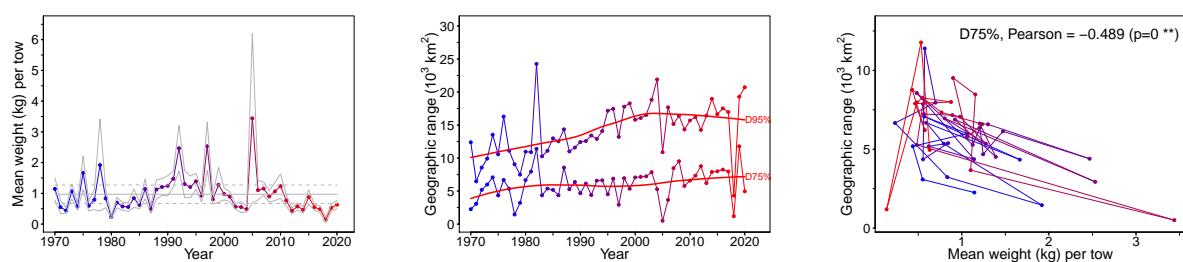


Figure 7.15B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Longhorn sculpin.

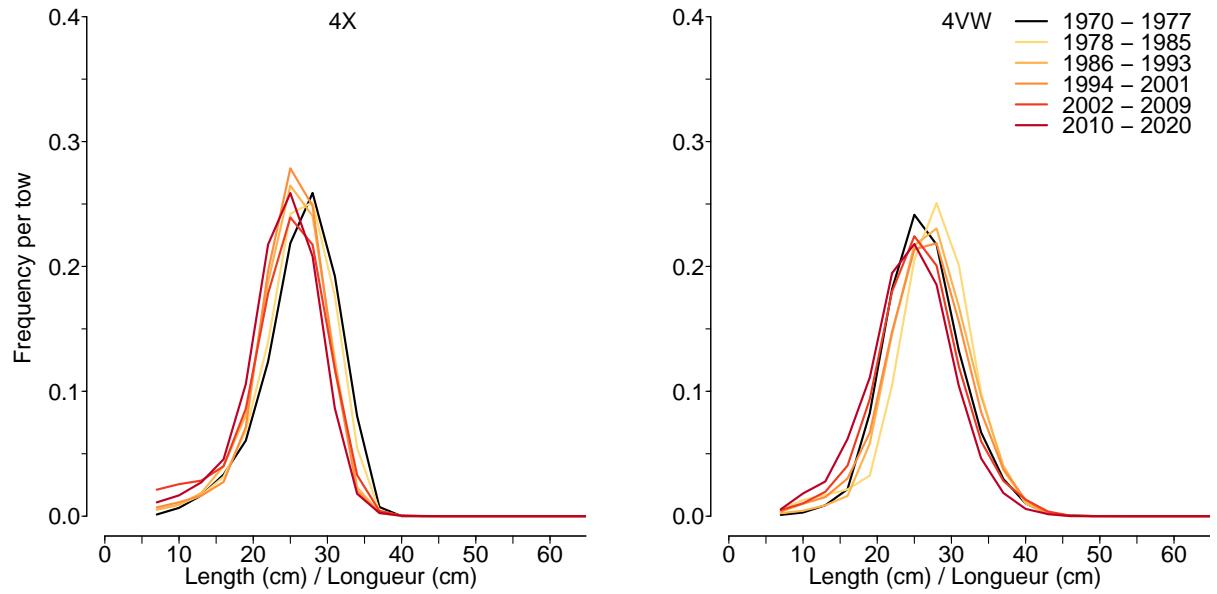


Figure 7.15C. Length frequency distribution in NAFO units 4X and 4VW for Longhorn sculpin.

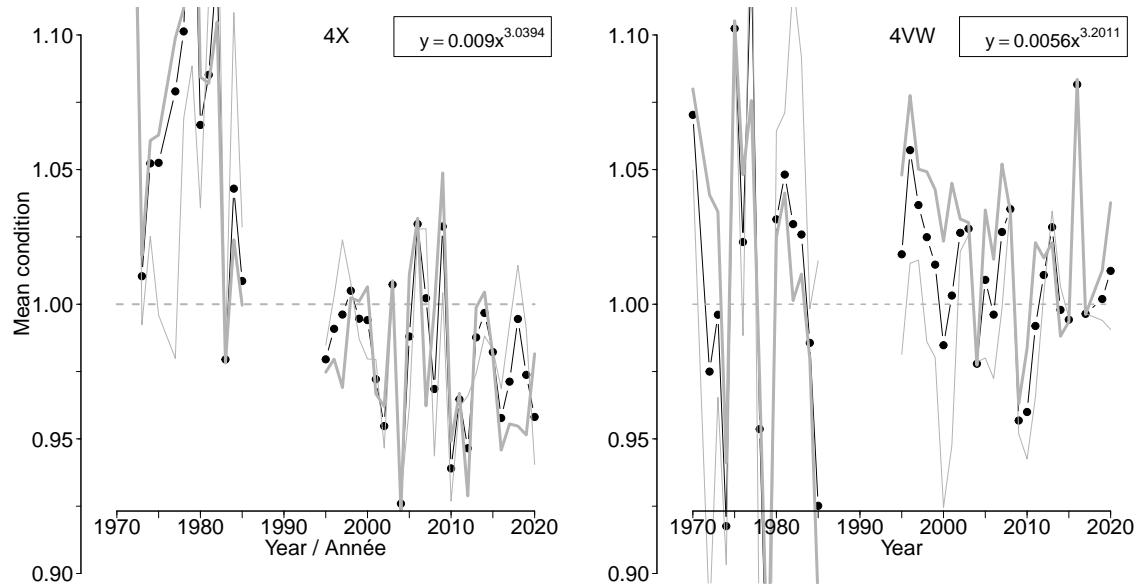


Figure 7.15D. Average fish condition in NAFO units 4X and 4VW for Longhorn sculpin.

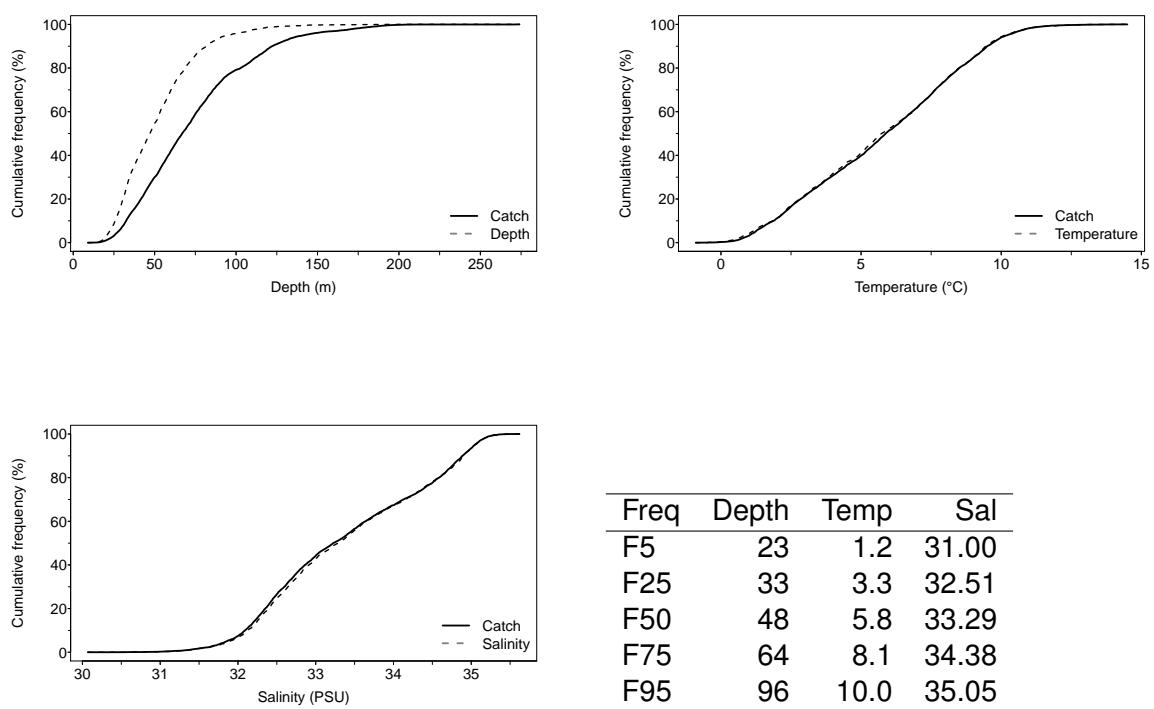


Figure 7.15E. Catch distribution by depth, temperature and salinity of Longhorn sculpin.

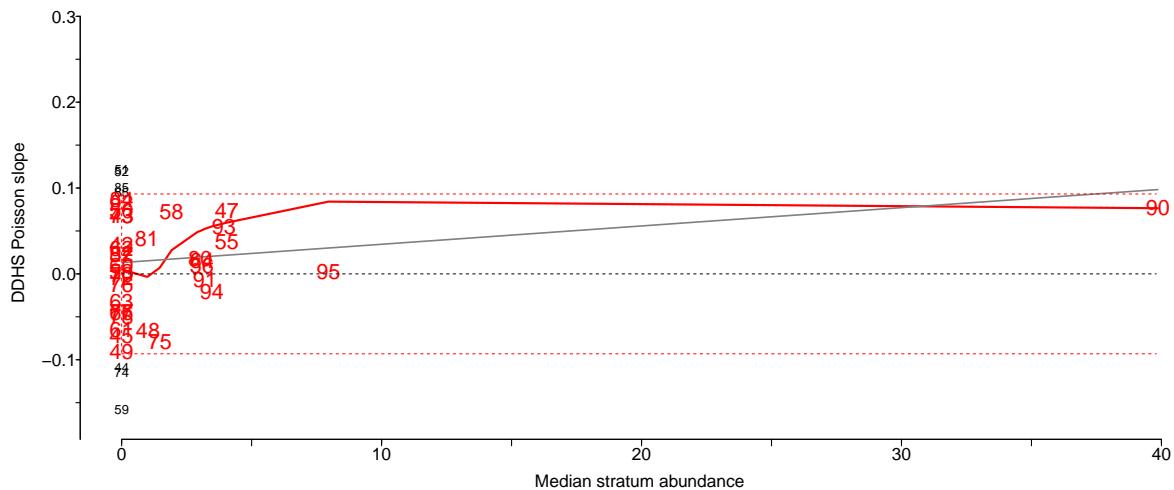


Figure 7.15F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Longhorn sculpin.

7.16 Moustache sculpin (Faux-trigle armé) - species code 304 (category LF)

Scientific name: [Triglops murrayi](#)

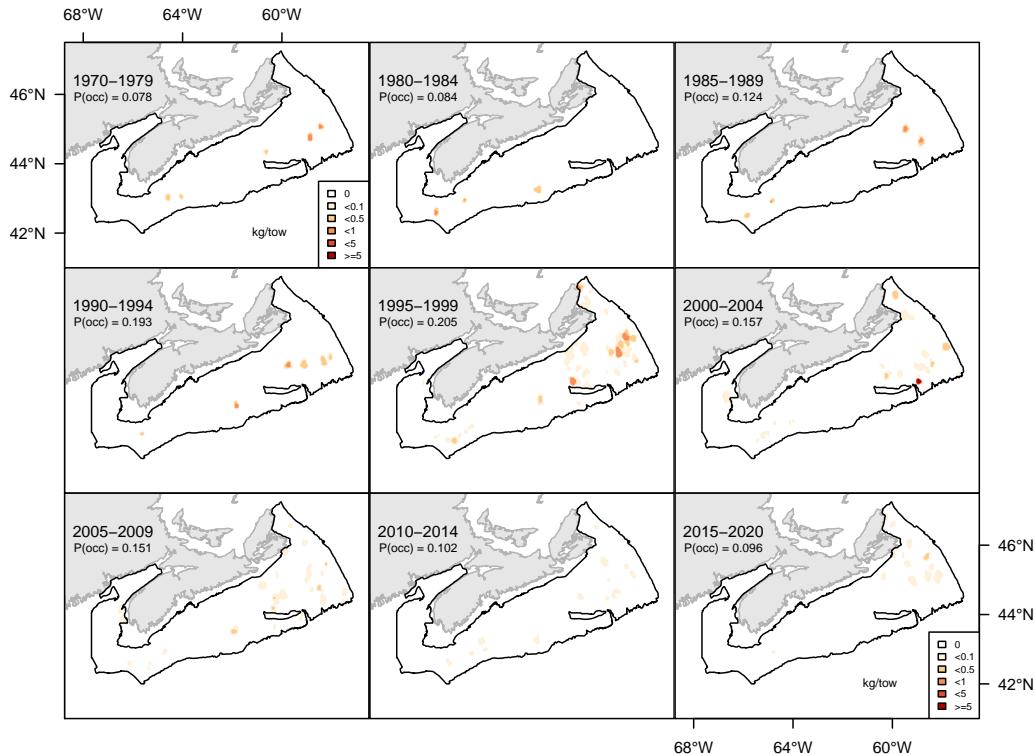


Figure 7.16A. Inverse distance weighted distribution of catch biomass (kg/tow) for Moustache sculpin.

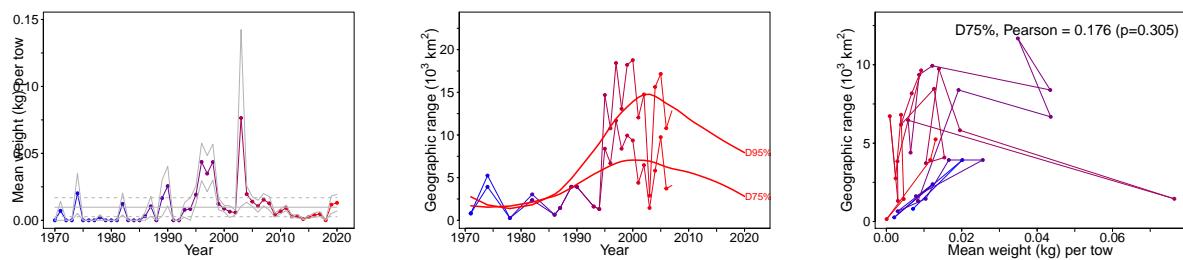


Figure 7.16B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Moustache sculpin.

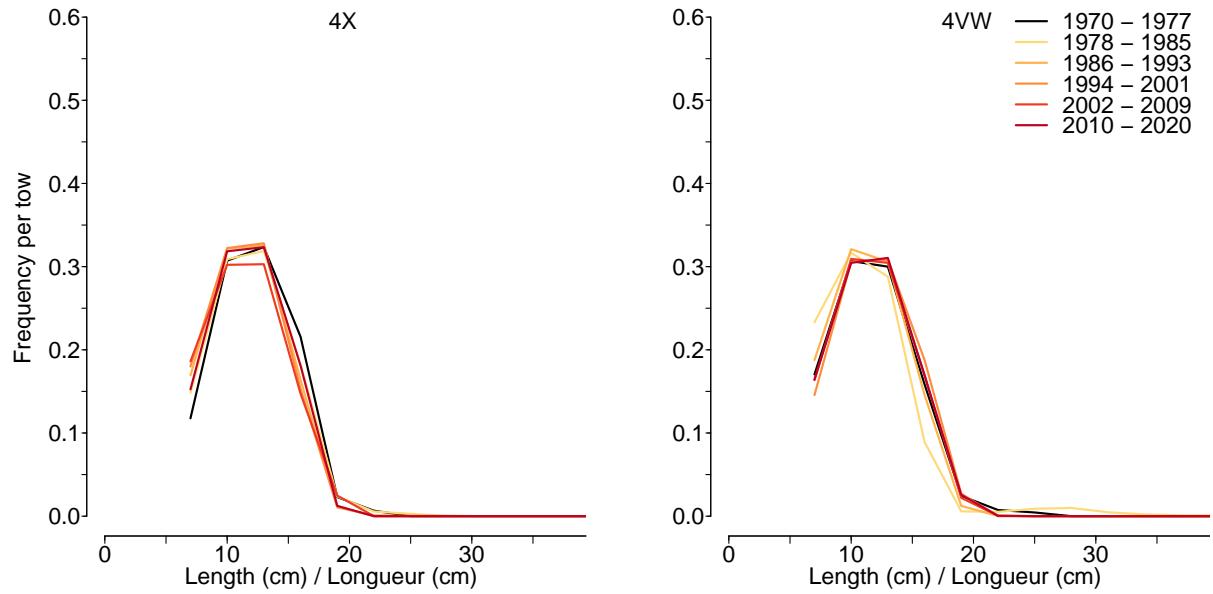


Figure 7.16C. Length frequency distribution in NAFO units 4X and 4VW for Moustache sculpin.

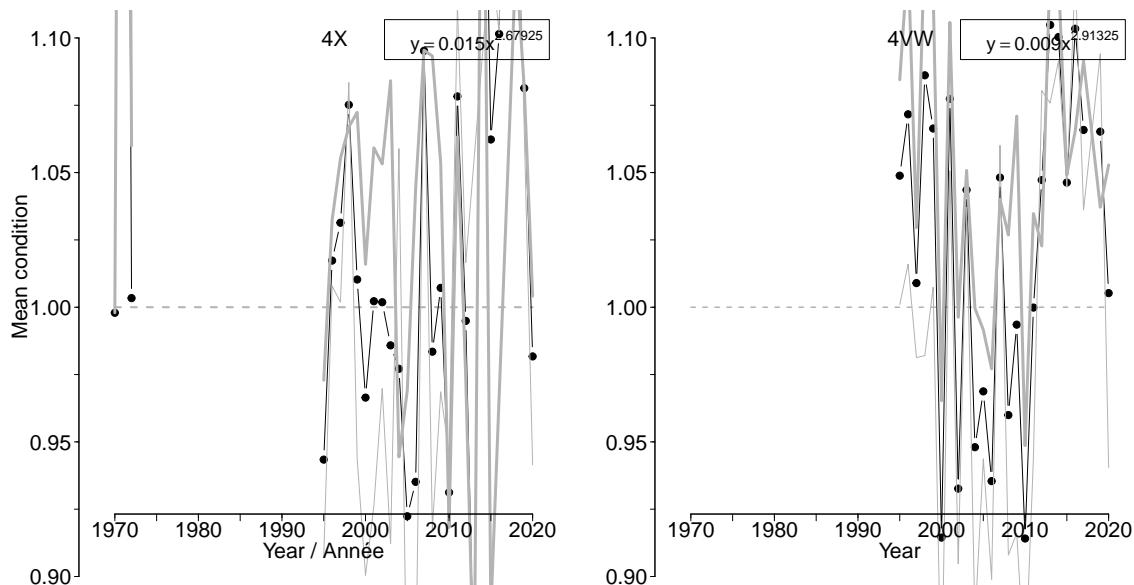


Figure 7.16D. Average fish condition in NAFO units 4X and 4VW for Moustache sculpin.

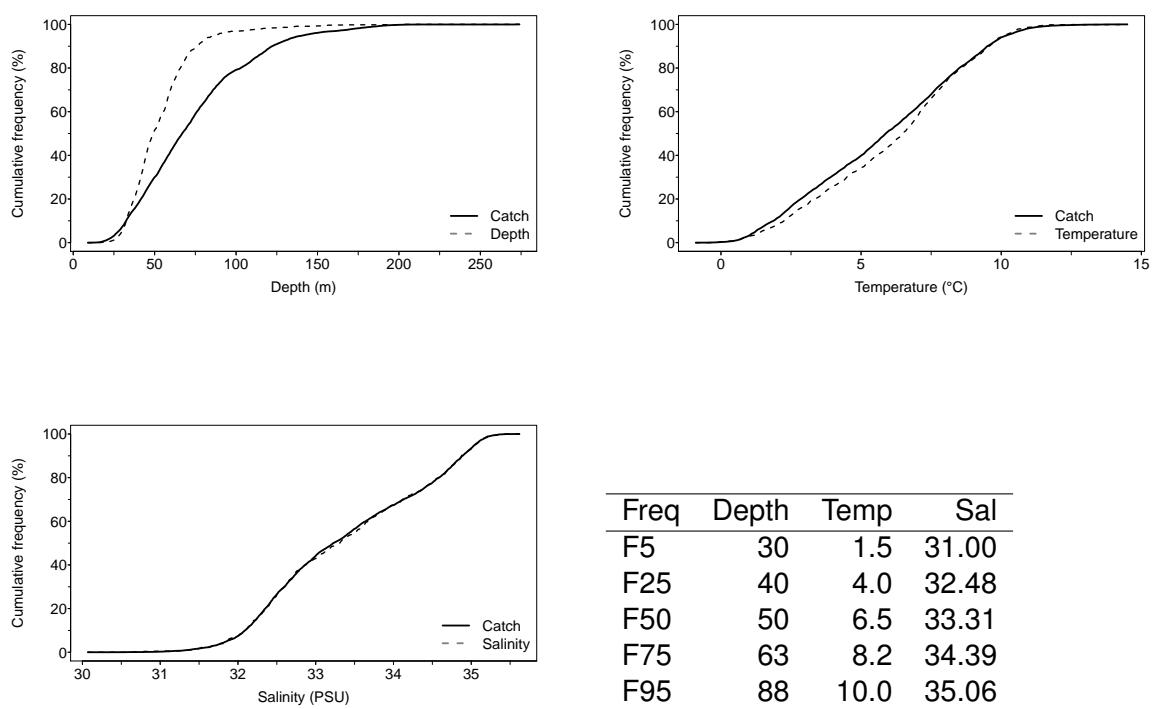


Figure 7.16E. Catch distribution by depth, temperature and salinity of Moustache sculpin.

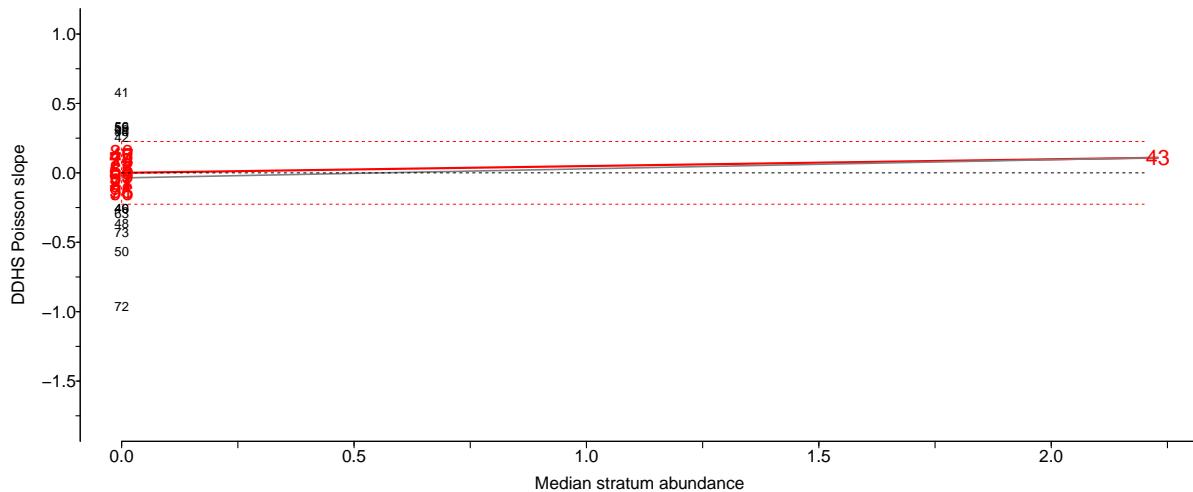


Figure 7.16F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Moustache sculpin.

7.17 Sea raven (Hémithriptère atlantique) - species code 320 (category LF)

Scientific name: [Hemitripterus americanus](#)

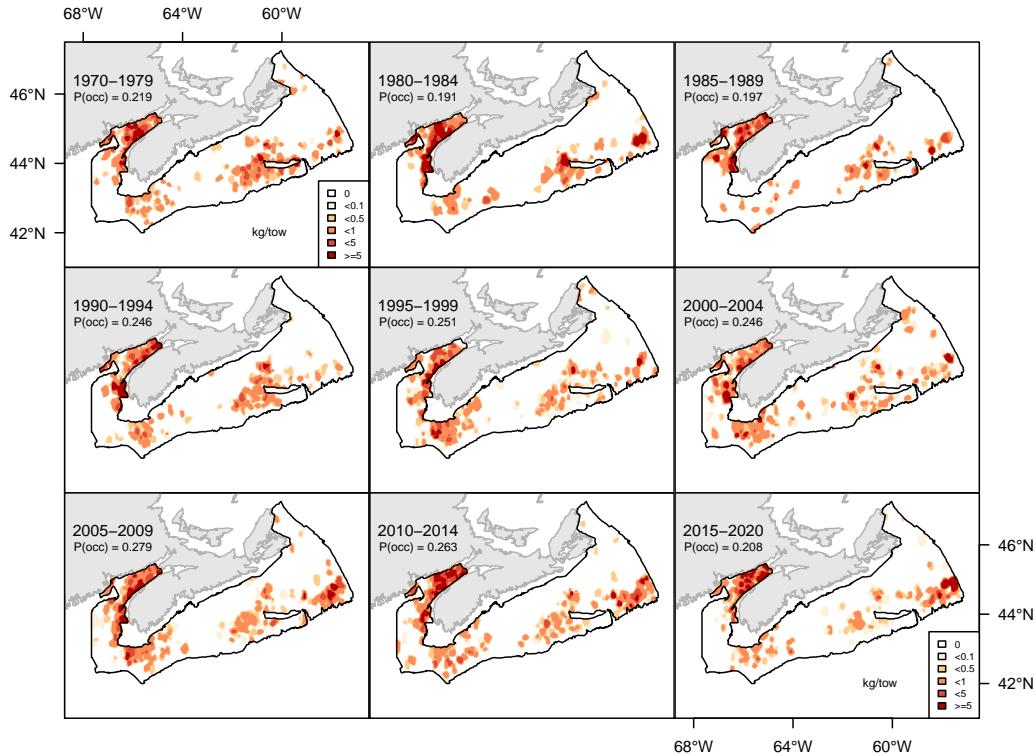


Figure 7.17A. Inverse distance weighted distribution of catch biomass (kg/tow) for Sea raven.

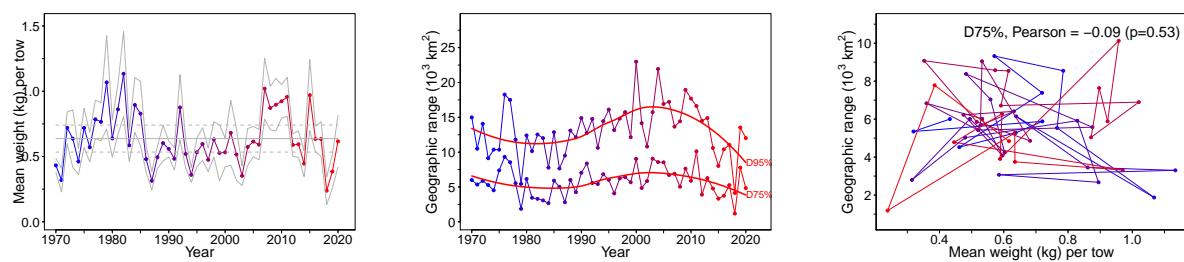


Figure 7.17B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Sea raven.

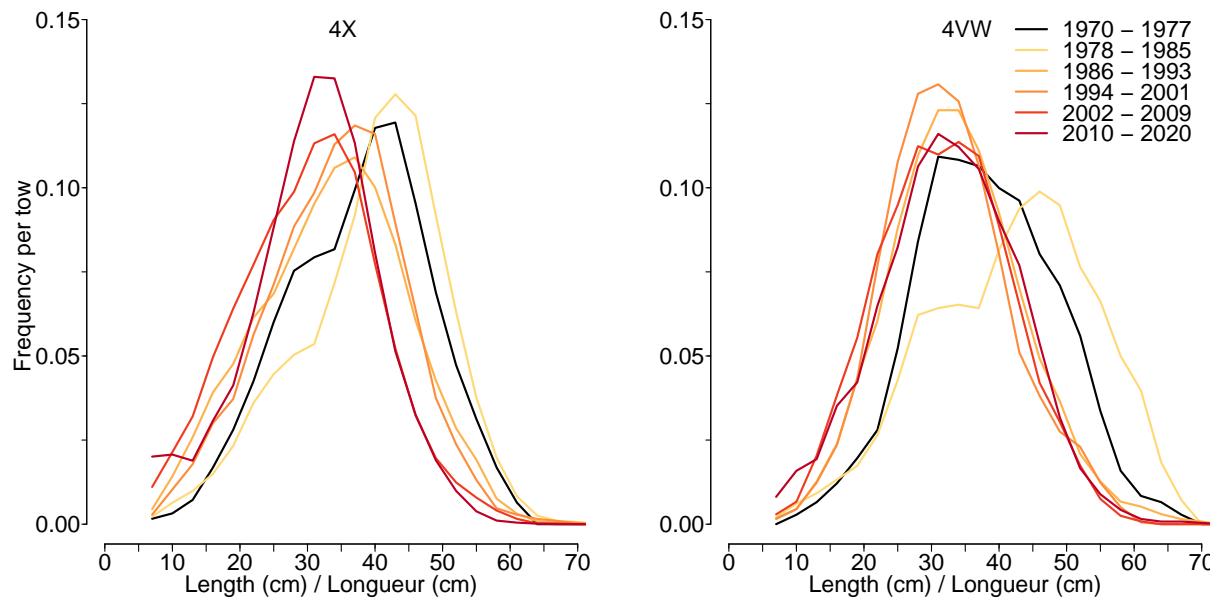


Figure 7.17C. Length frequency distribution in NAFO units 4X and 4VW for Sea raven.

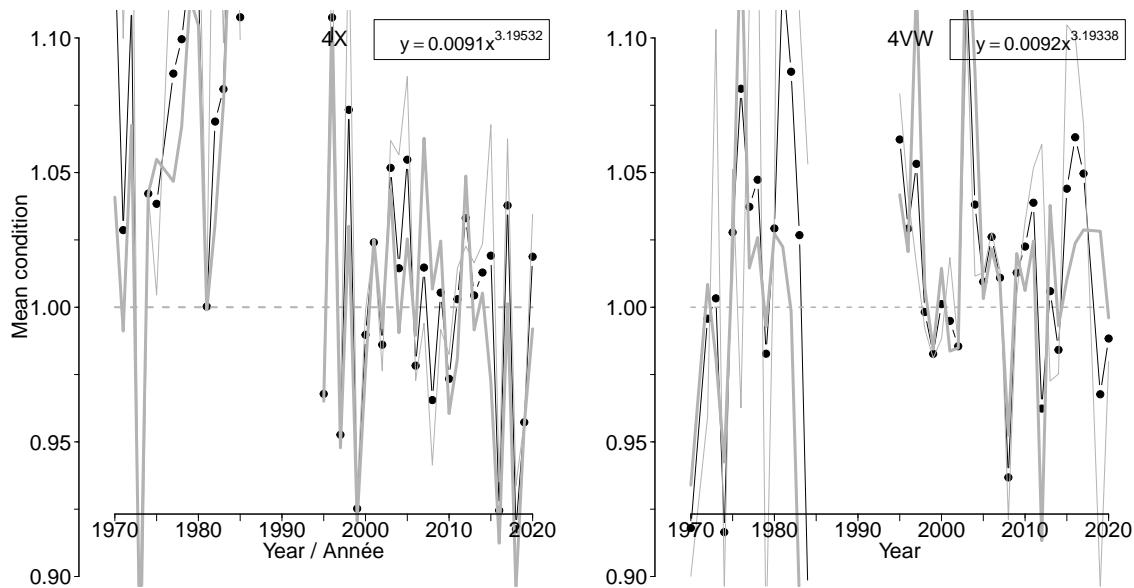
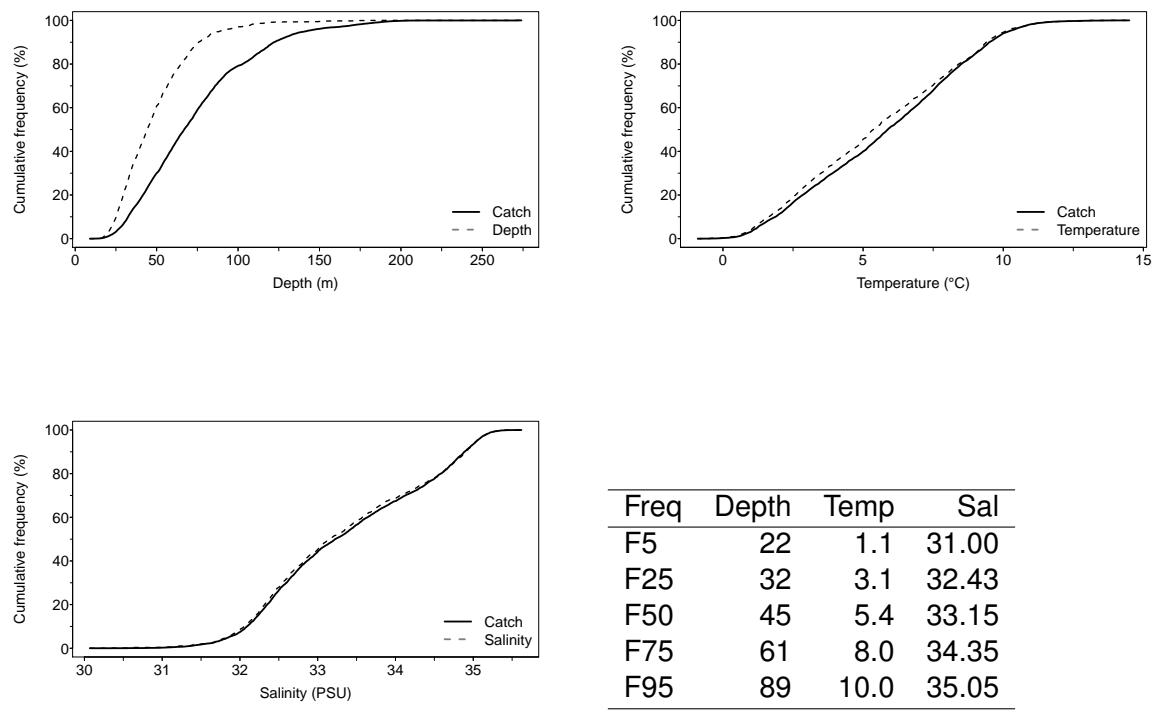


Figure 7.17D. Average fish condition in NAFO units 4X and 4VW for Sea raven.



Freq	Depth	Temp	Sal
F5	22	1.1	31.00
F25	32	3.1	32.43
F50	45	5.4	33.15
F75	61	8.0	34.35
F95	89	10.0	35.05

Figure 7.17E. Catch distribution by depth, temperature and salinity of Sea raven.

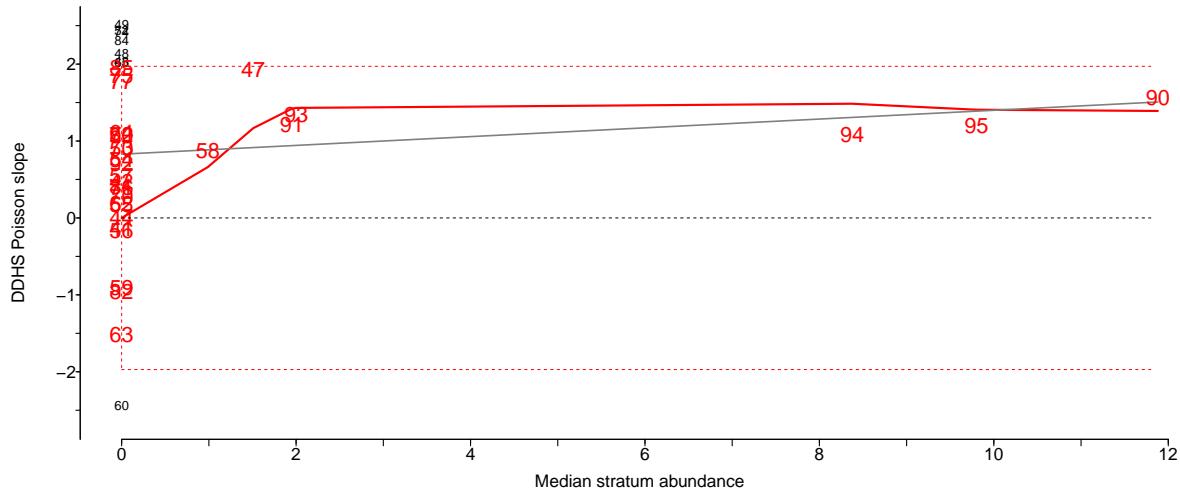


Figure 7.17F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Sea raven.

7.18 Alligatorfish (Poisson-alligator atlantique) - species code 340 (category LF)

Scientific name: [Aspidophoroides monopterygius](#)

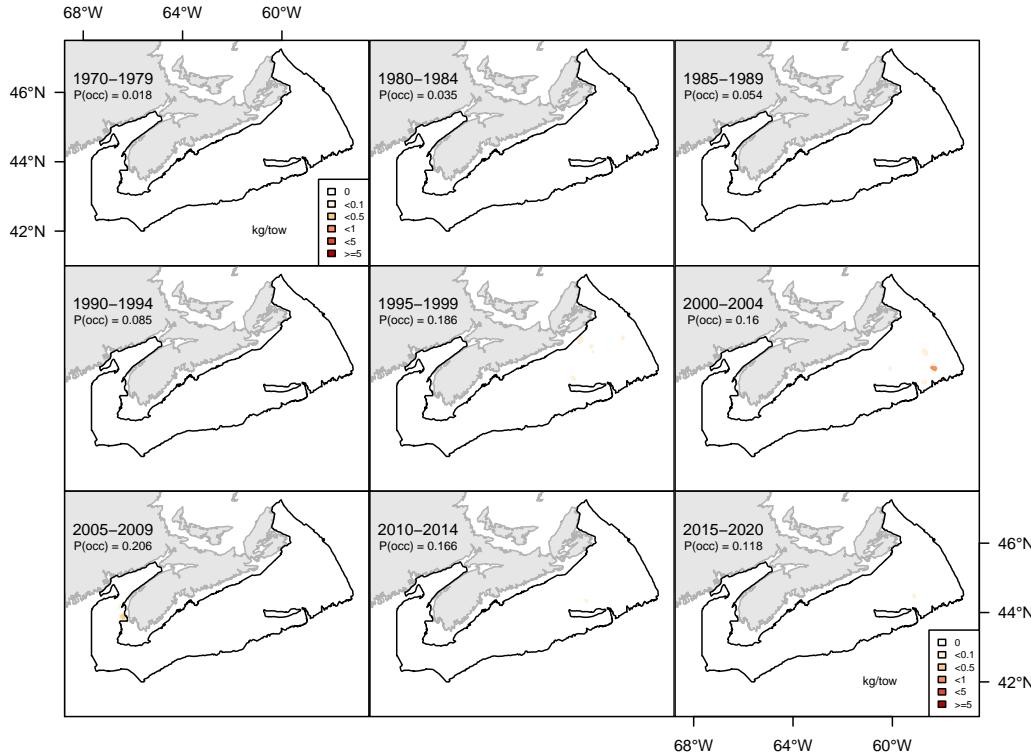


Figure 7.18A. Inverse distance weighted distribution of catch biomass (kg/tow) for Alligatorfish.

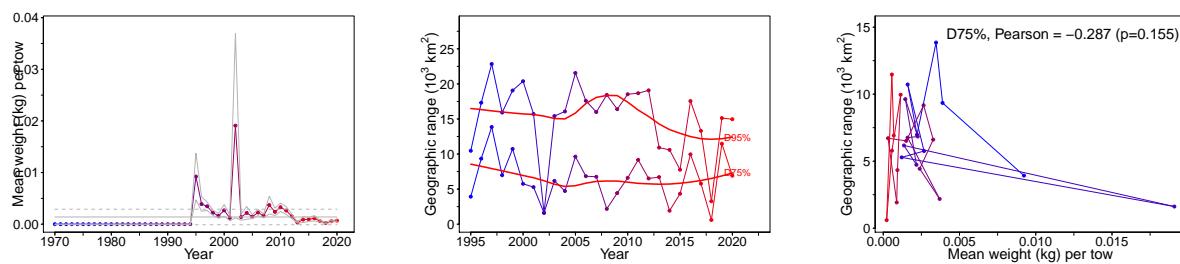


Figure 7.18B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Alligatorfish.

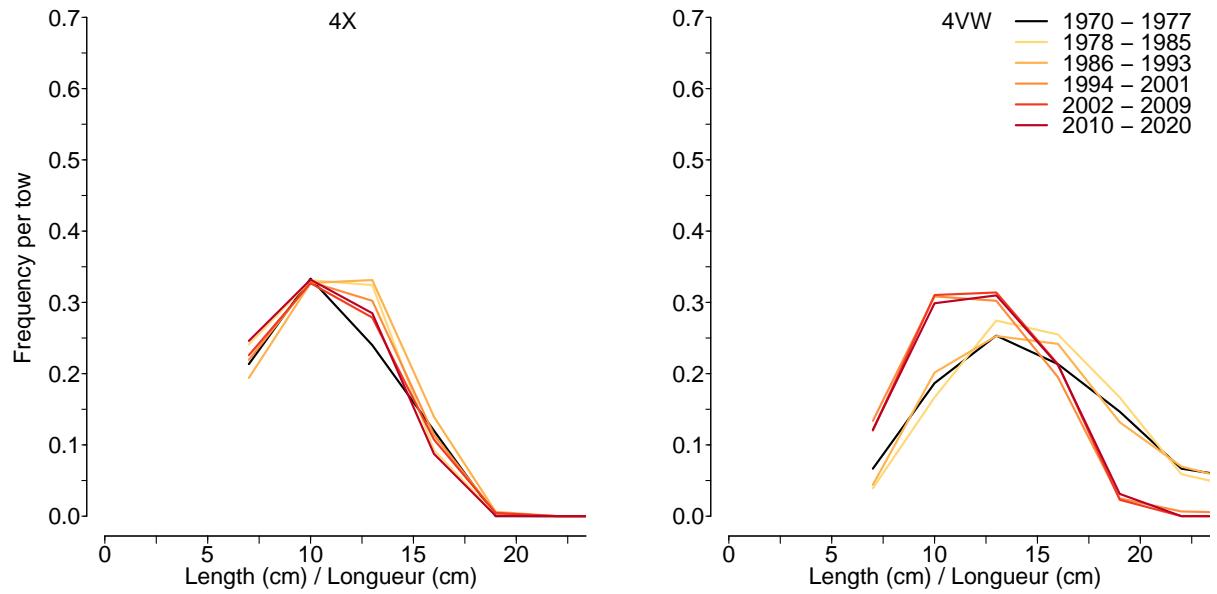


Figure 7.18C. Length frequency distribution in NAFO units 4X and 4VW for Alligatorfish.

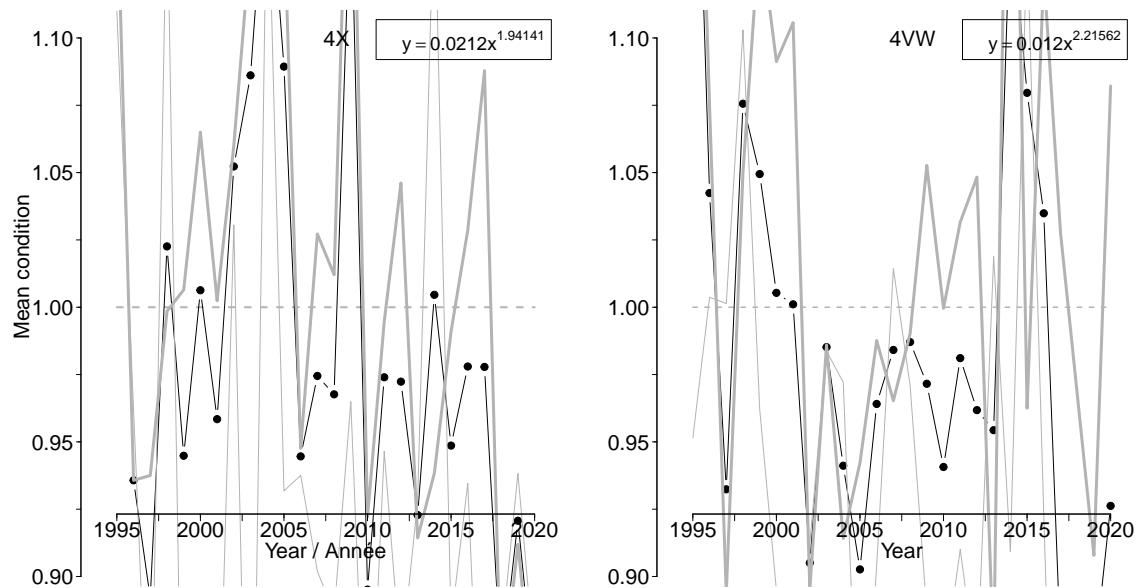


Figure 7.18D. Average fish condition in NAFO units 4X and 4VW for Alligatorfish.

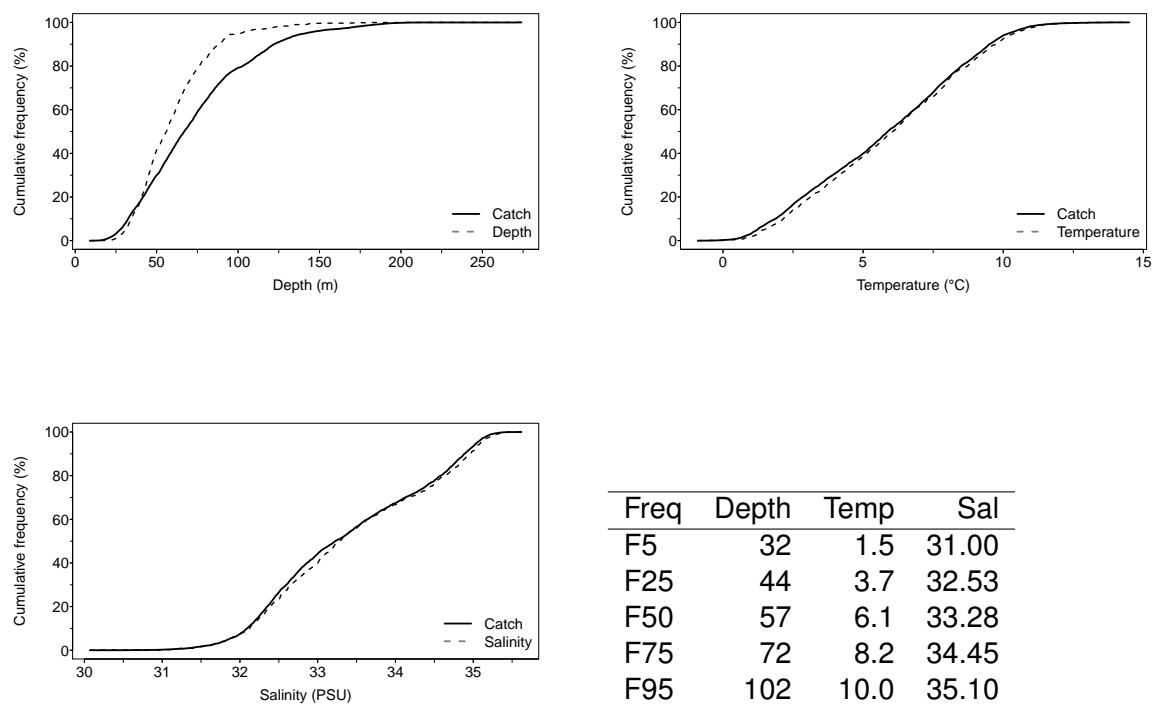


Figure 7.18E. Catch distribution by depth, temperature and salinity of Alligatorfish.

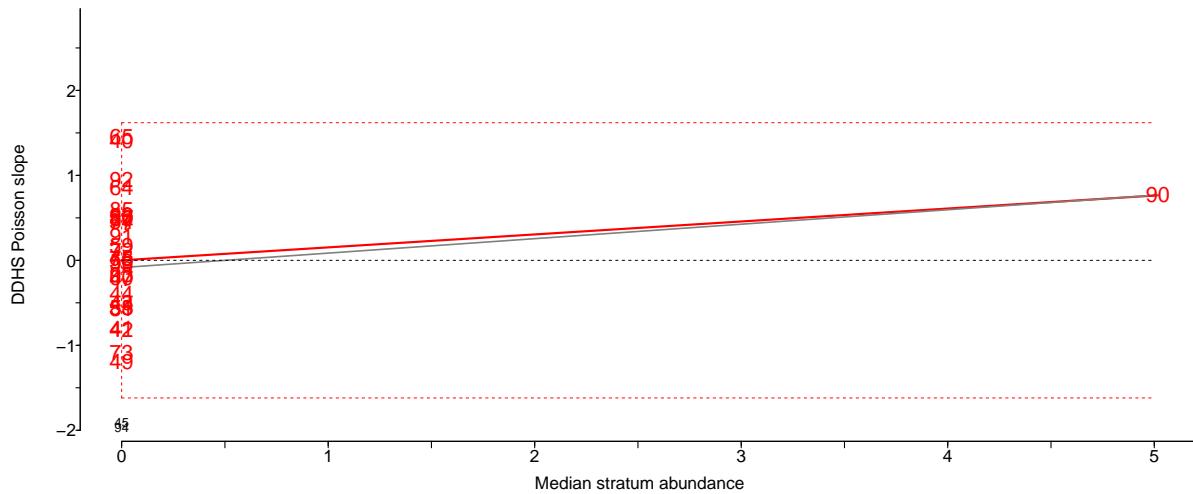


Figure 7.18F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Alligatorfish.

7.19 Monkfish (Baudroie d'Amérique) - species code 400 (category LF)

Scientific name: [Lophius americanus](#)

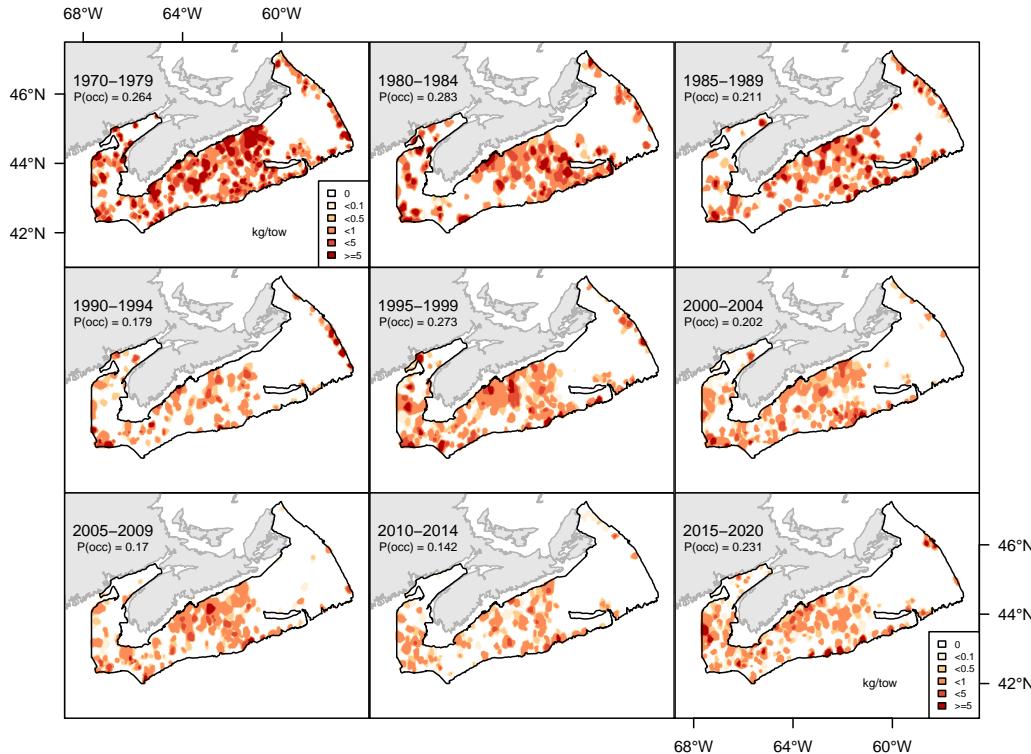


Figure 7.19A. Inverse distance weighted distribution of catch biomass (kg/tow) for Monkfish.

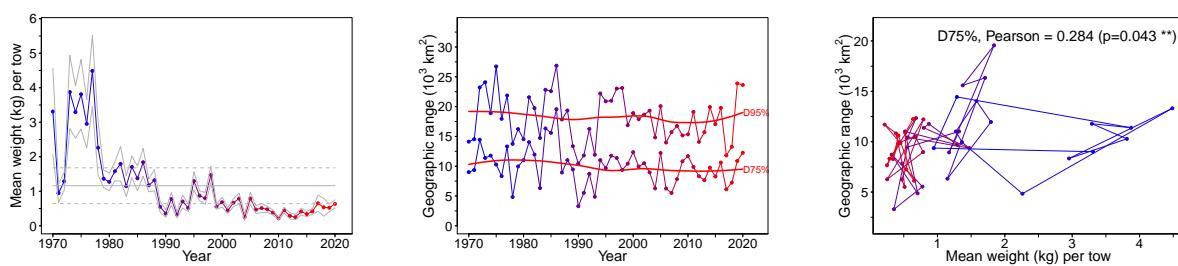


Figure 7.19B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Monkfish.

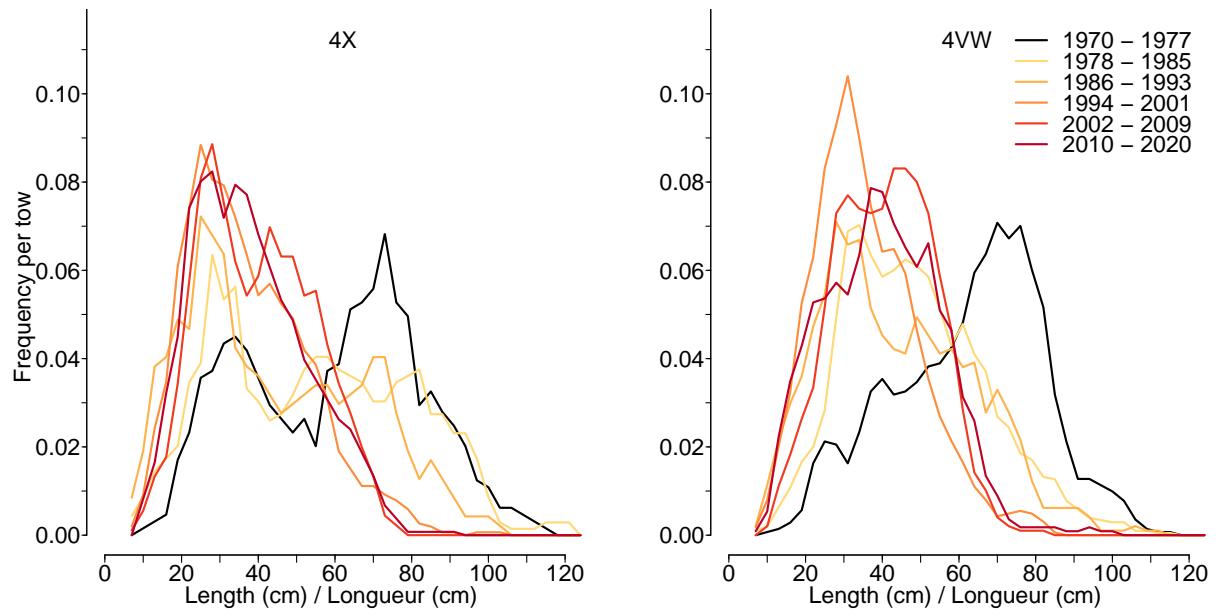


Figure 7.19C. Length frequency distribution in NAFO units 4X and 4VW for Monkfish.

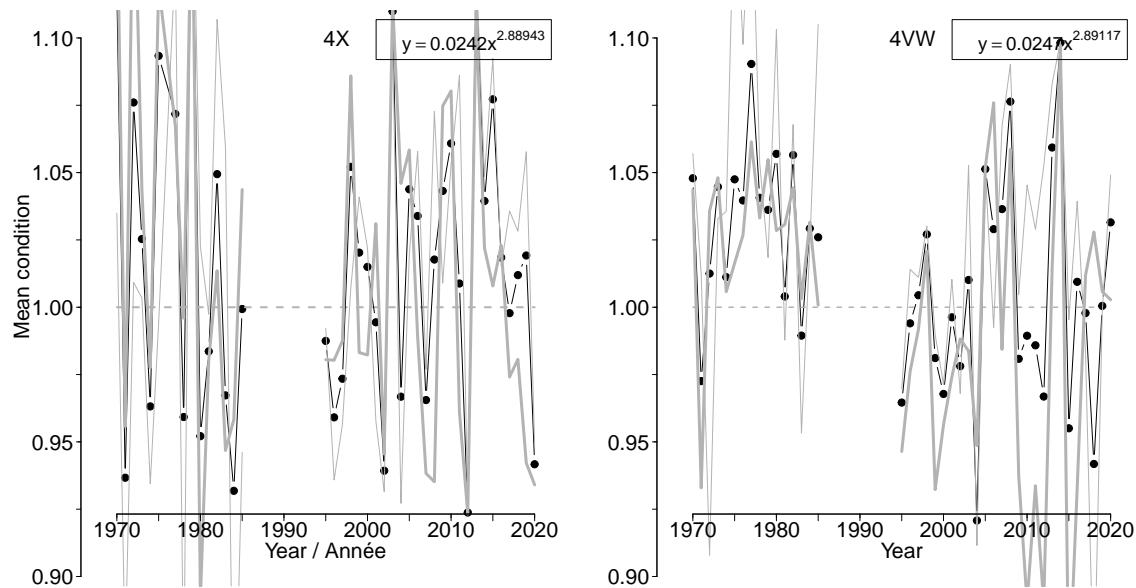
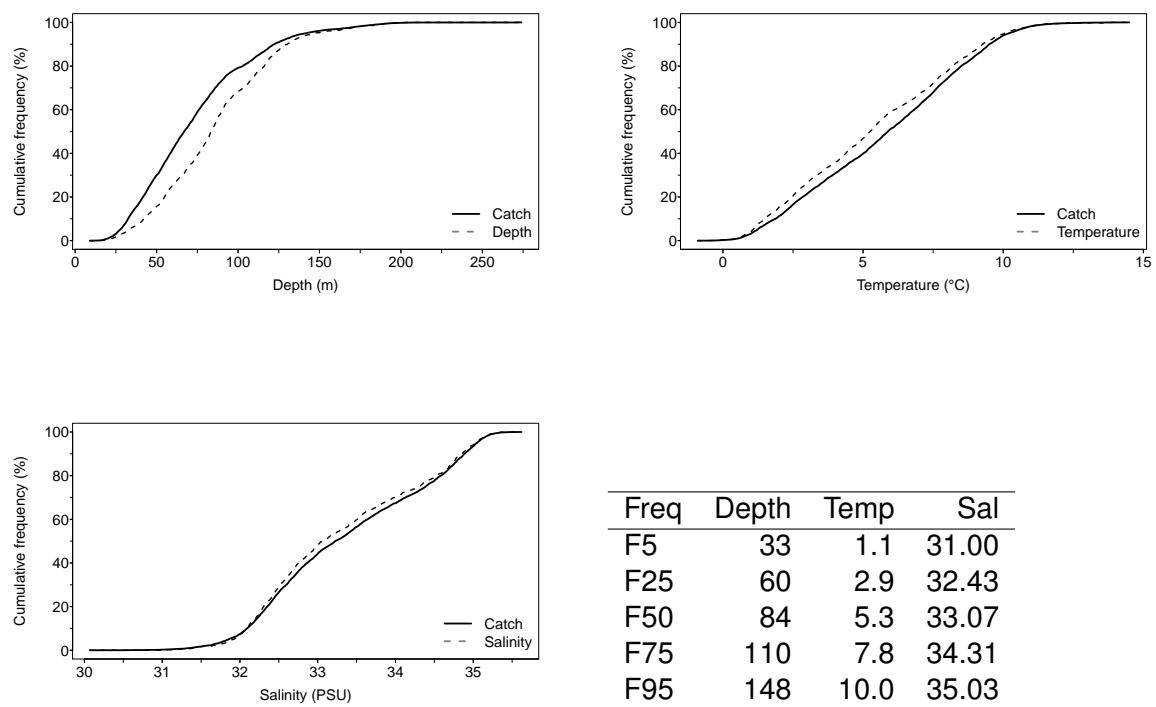


Figure 7.19D. Average fish condition in NAFO units 4X and 4VW for Monkfish.



Freq	Depth	Temp	Sal
F5	33	1.1	31.00
F25	60	2.9	32.43
F50	84	5.3	33.07
F75	110	7.8	34.31
F95	148	10.0	35.03

Figure 7.19E. Catch distribution by depth, temperature and salinity of Monkfish.

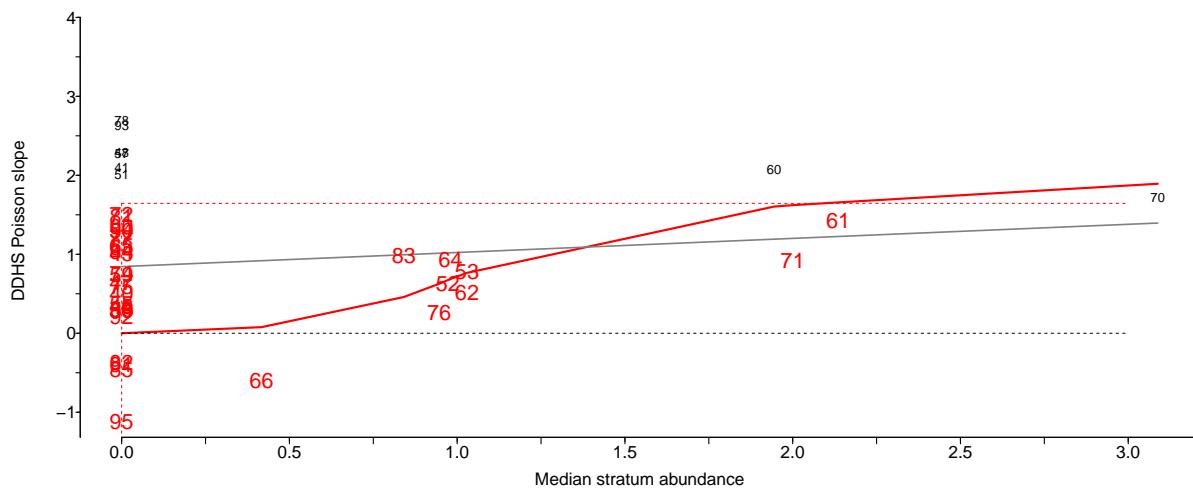


Figure 7.19F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Monkfish.

7.20 Ocean pout (Loquette d'Amérique) - species code 640 (category LF)

Scientific name: [Zoarces americanus](#)

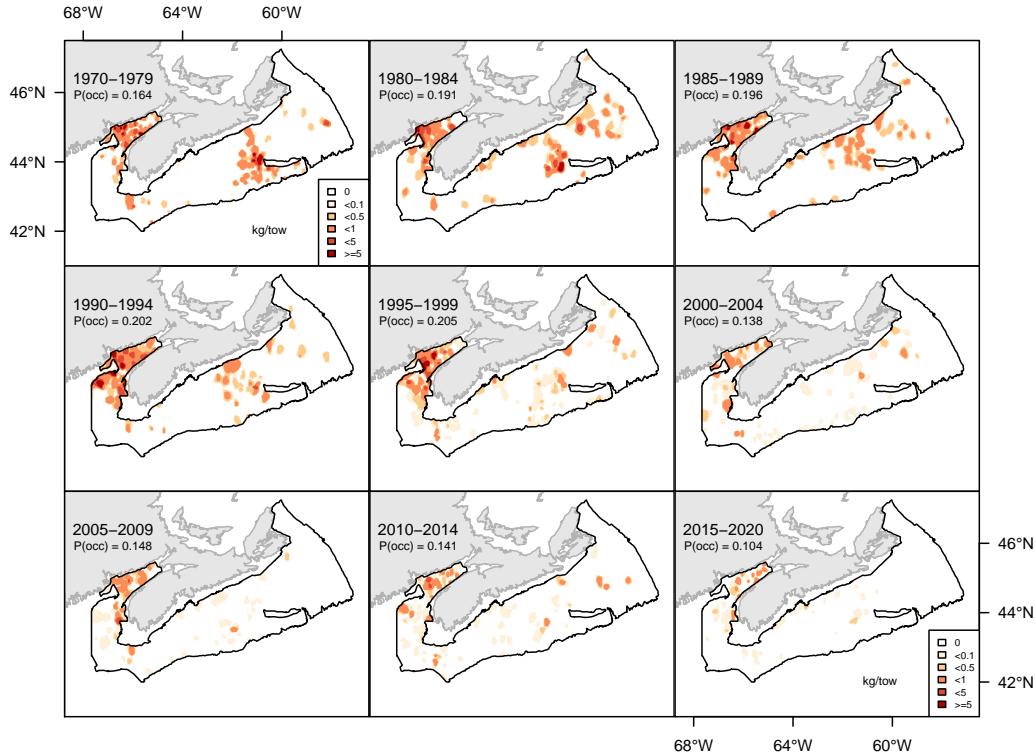


Figure 7.20A. Inverse distance weighted distribution of catch biomass (kg/tow) for Ocean pout.

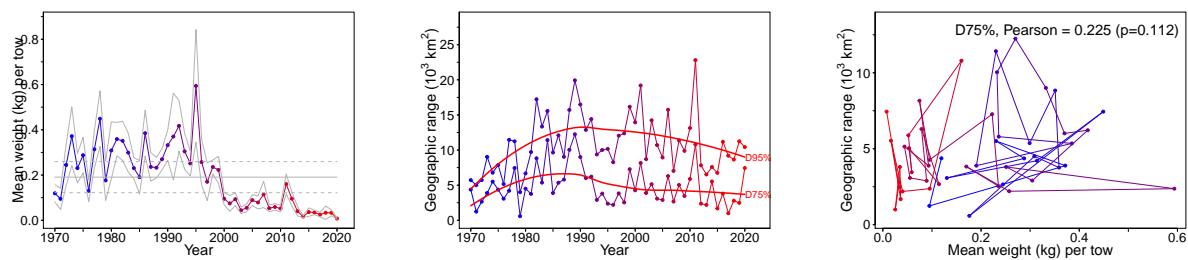


Figure 7.20B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Ocean pout.

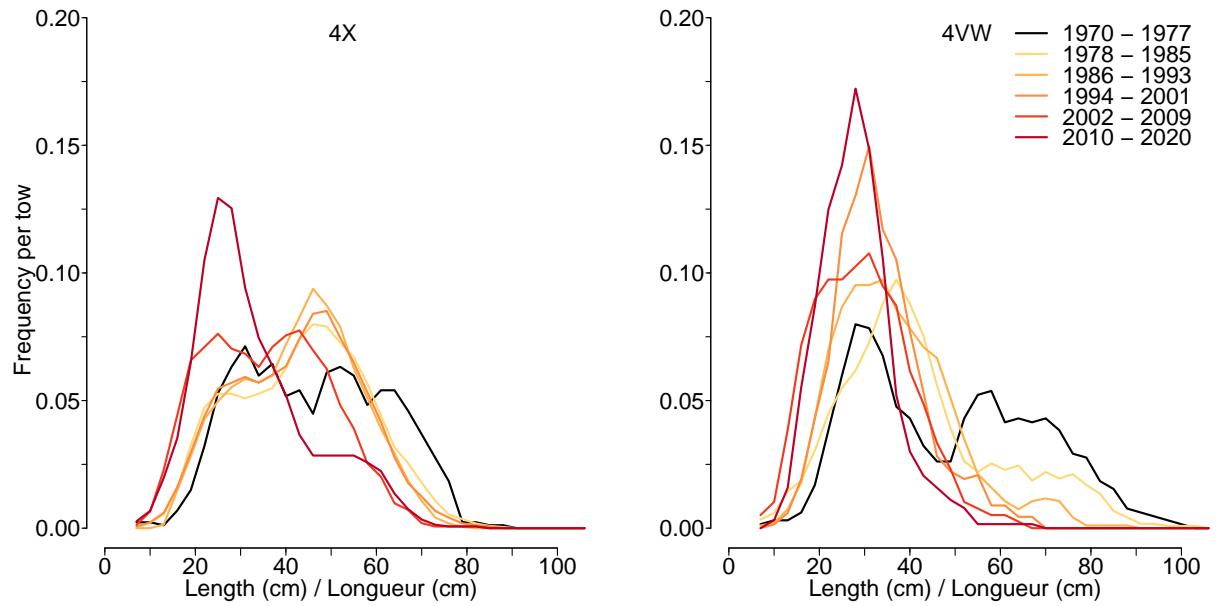


Figure 7.20C. Length frequency distribution in NAFO units 4X and 4VW for Ocean pout.

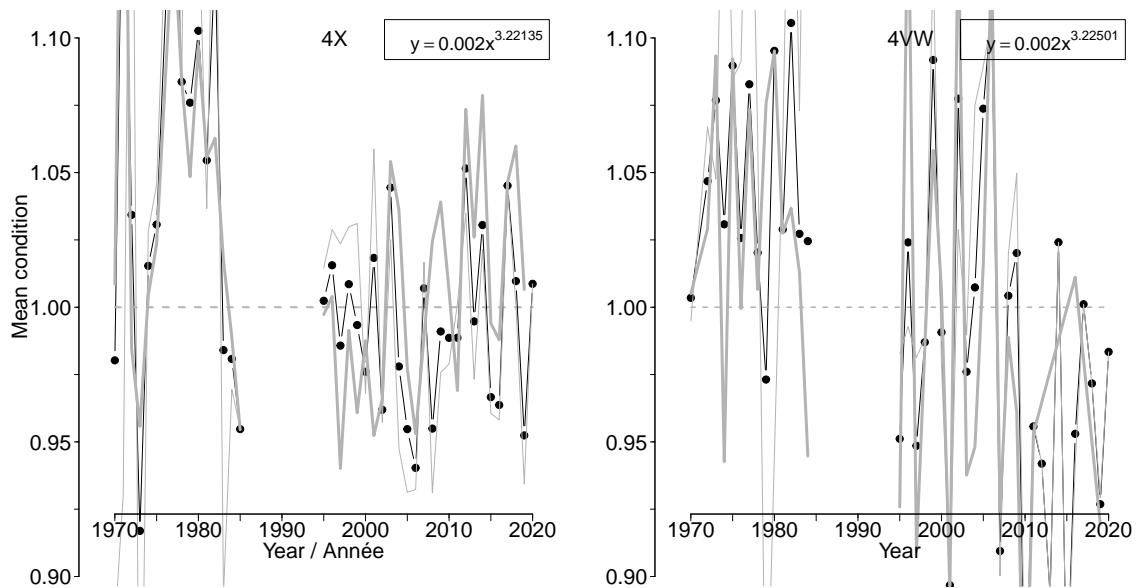


Figure 7.20D. Average fish condition in NAFO units 4X and 4VW for Ocean pout.

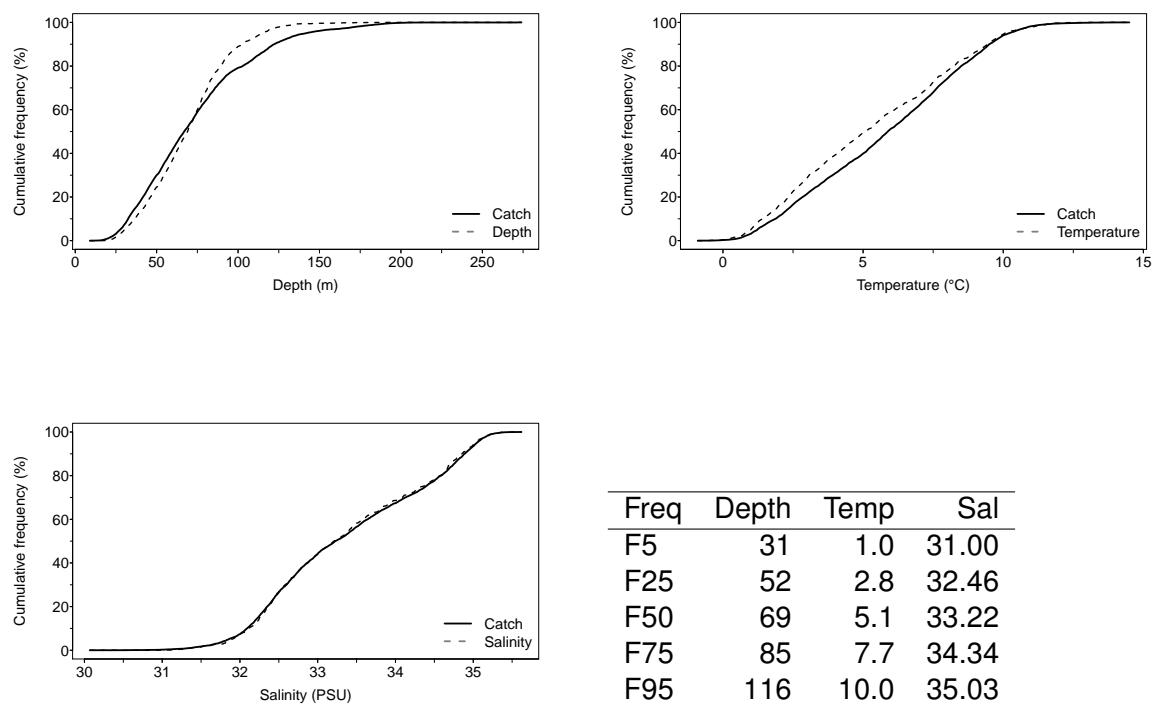


Figure 7.20E. Catch distribution by depth, temperature and salinity of Ocean pout.

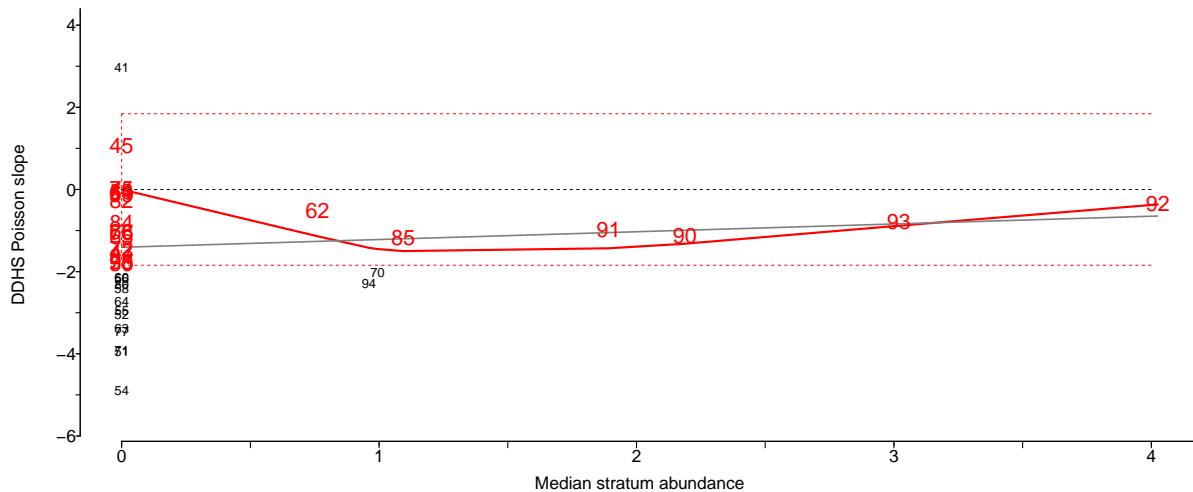


Figure 7.20F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Ocean pout.

7.21 Thorny skate (Raie épineuse) - species code 201 (category LF)

Scientific name: [Amblyraja radiata](#)

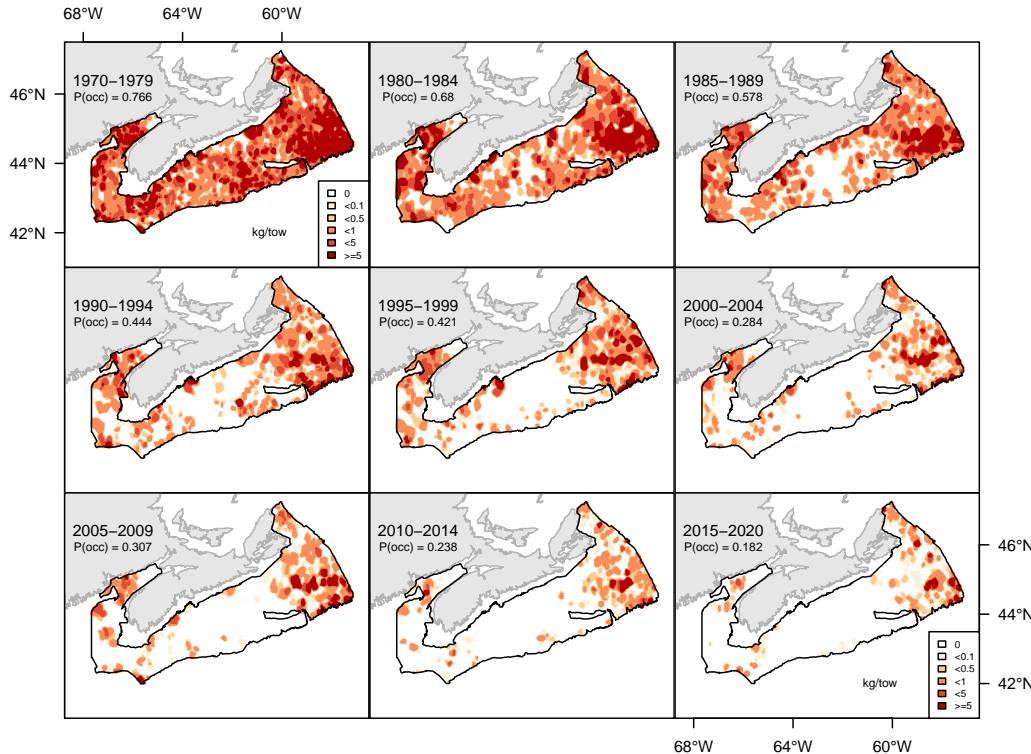


Figure 7.21A. Inverse distance weighted distribution of catch biomass (kg/tow) for Thorny skate.

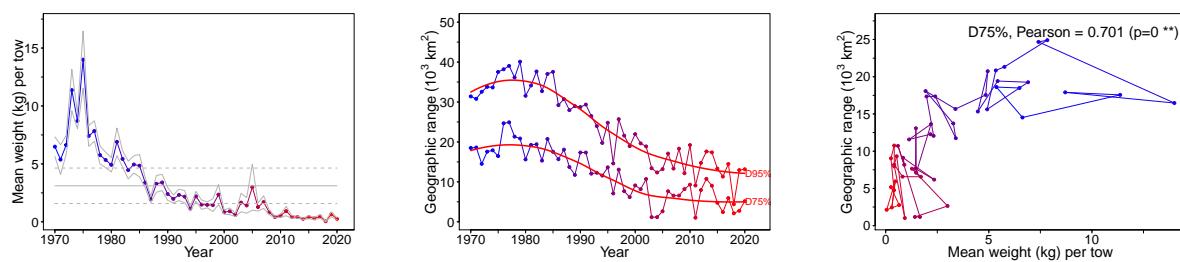


Figure 7.21B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Thorny skate.

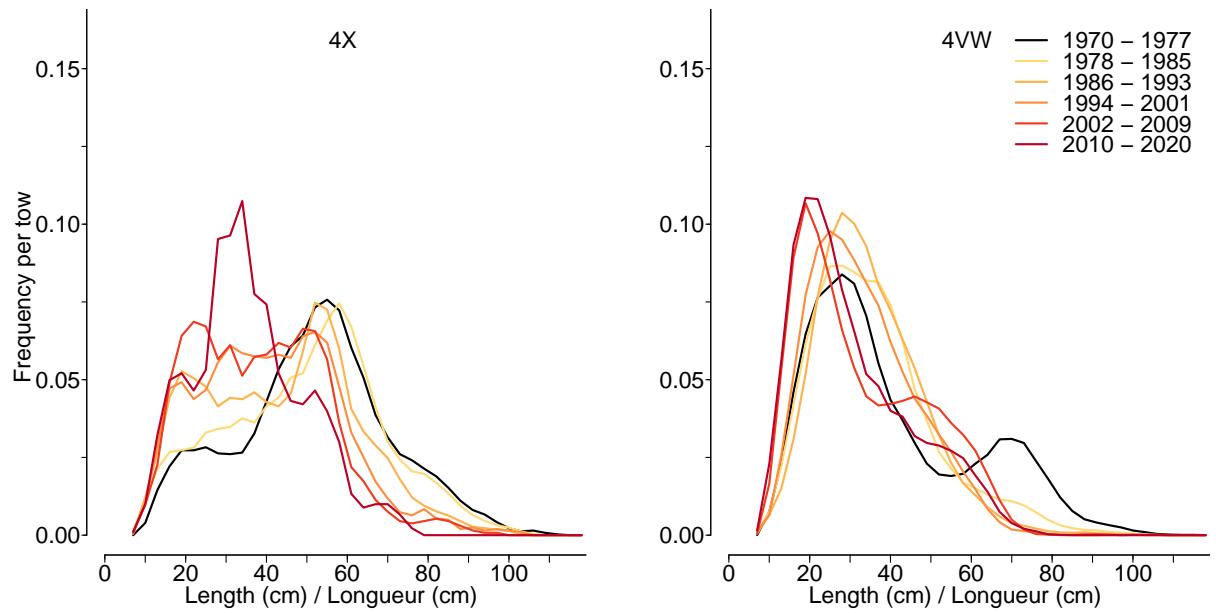


Figure 7.21C. Length frequency distribution in NAFO units 4X and 4VW for Thorny skate.

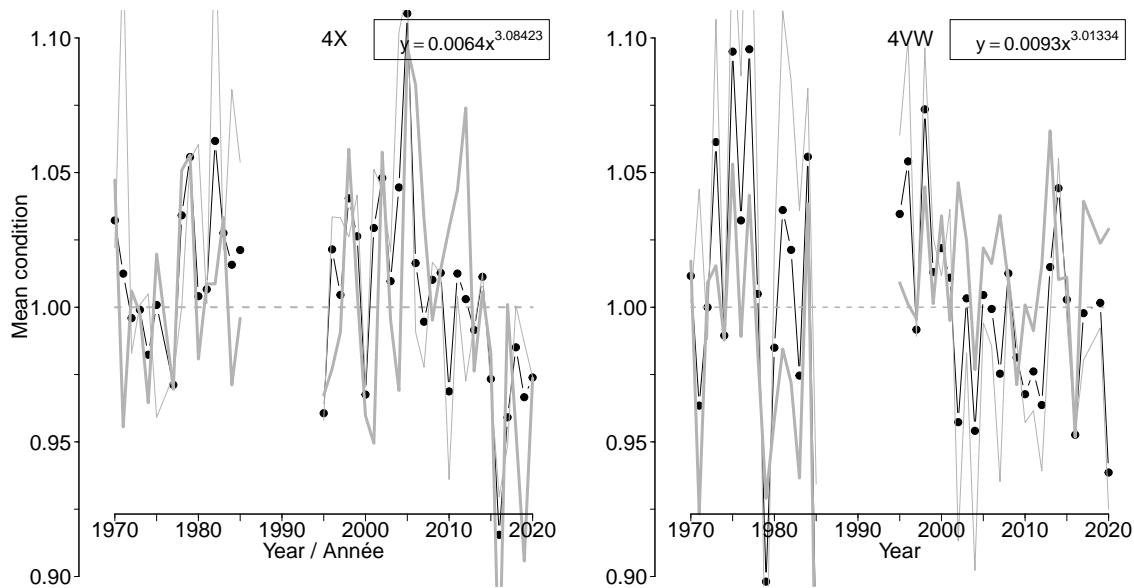


Figure 7.21D. Average fish condition in NAFO units 4X and 4VW for Thorny skate.

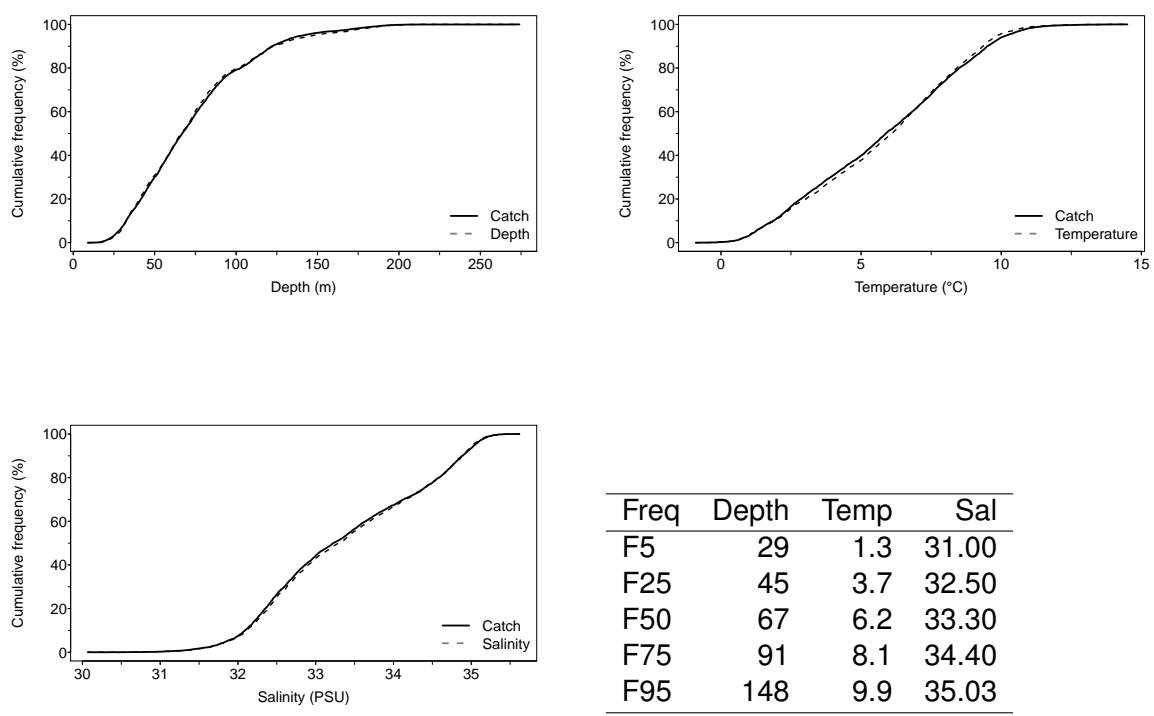


Figure 7.21E. Catch distribution by depth, temperature and salinity of Thorny skate.

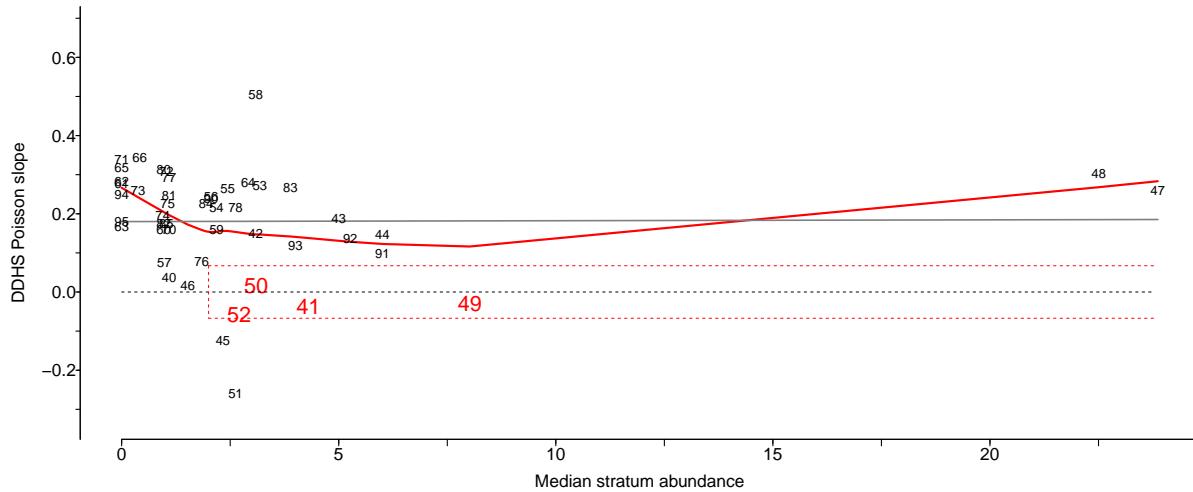


Figure 7.21F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Thorny skate.

7.22 Smooth skate (Raie lisse) - species code 202 (category LF)

Scientific name: [Malacoraja senta](#)

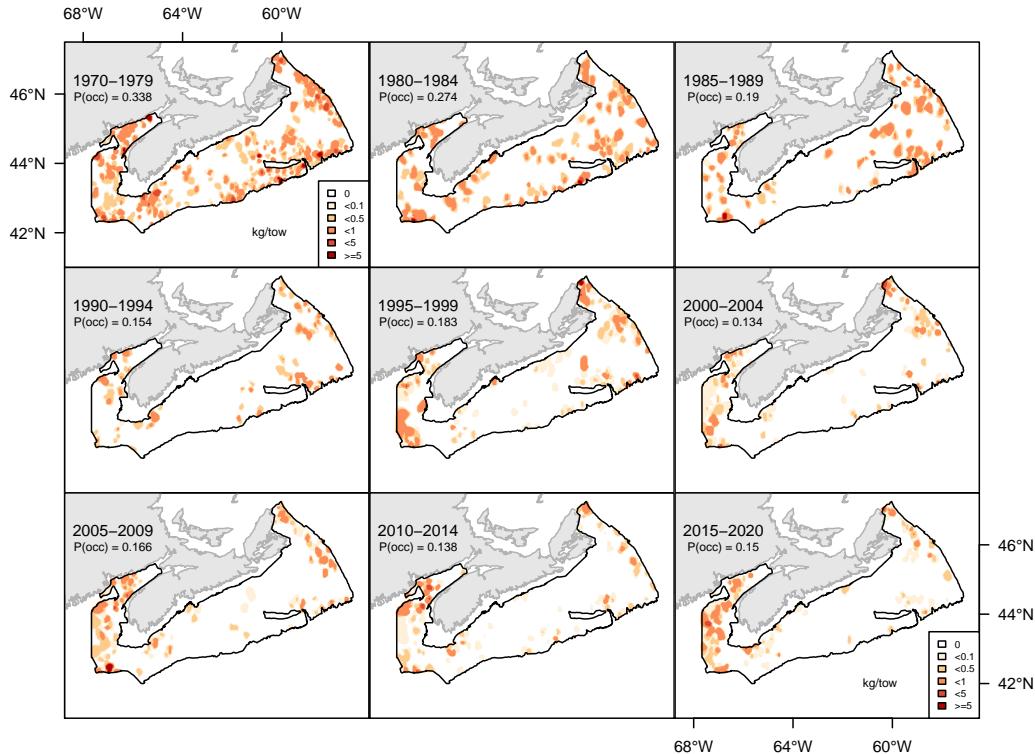


Figure 7.22A. Inverse distance weighted distribution of catch biomass (kg/tow) for Smooth skate.

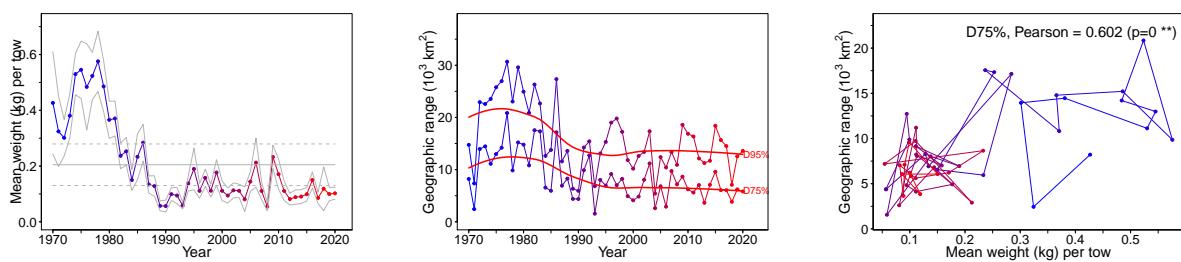


Figure 7.22B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Smooth skate.

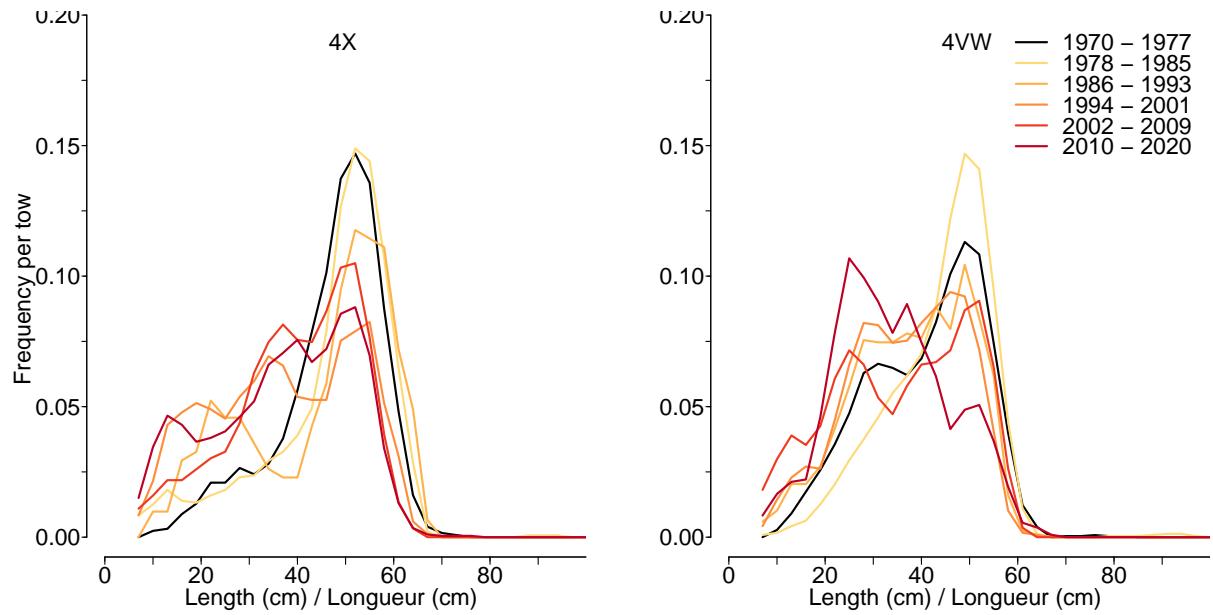


Figure 7.22C. Length frequency distribution in NAFO units 4X and 4VW for Smooth skate.

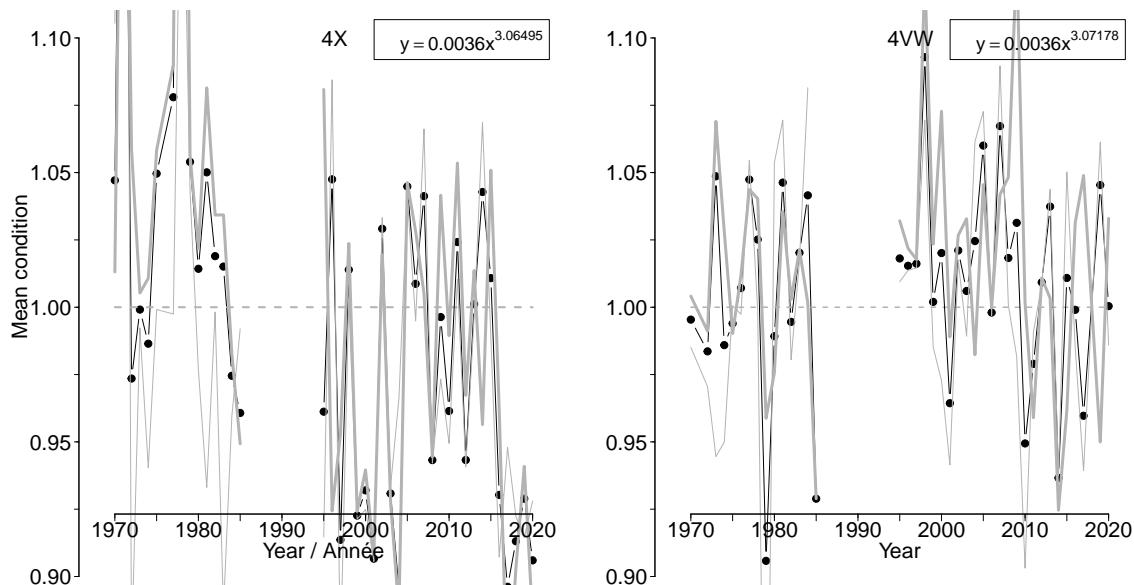


Figure 7.22D. Average fish condition in NAFO units 4X and 4VW for Smooth skate.

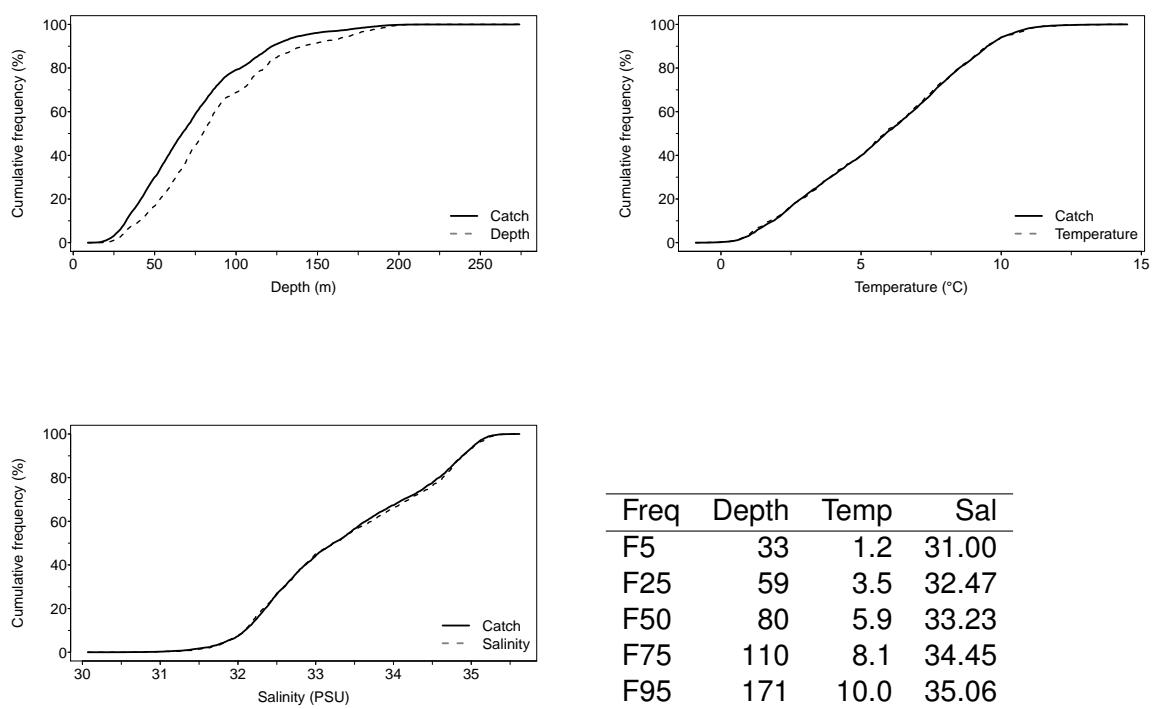


Figure 7.22E. Catch distribution by depth, temperature and salinity of Smooth skate.

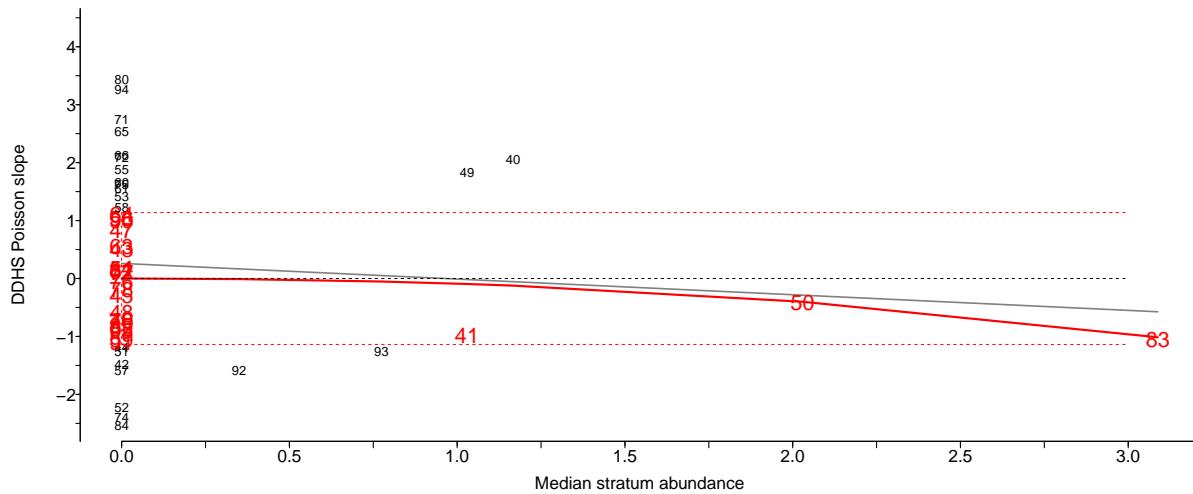


Figure 7.22F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Smooth skate.

7.23 Winter skate (Raie tachetée) - species code 204 (category LF)

Scientific name: [Leucoraja ocellata](#)

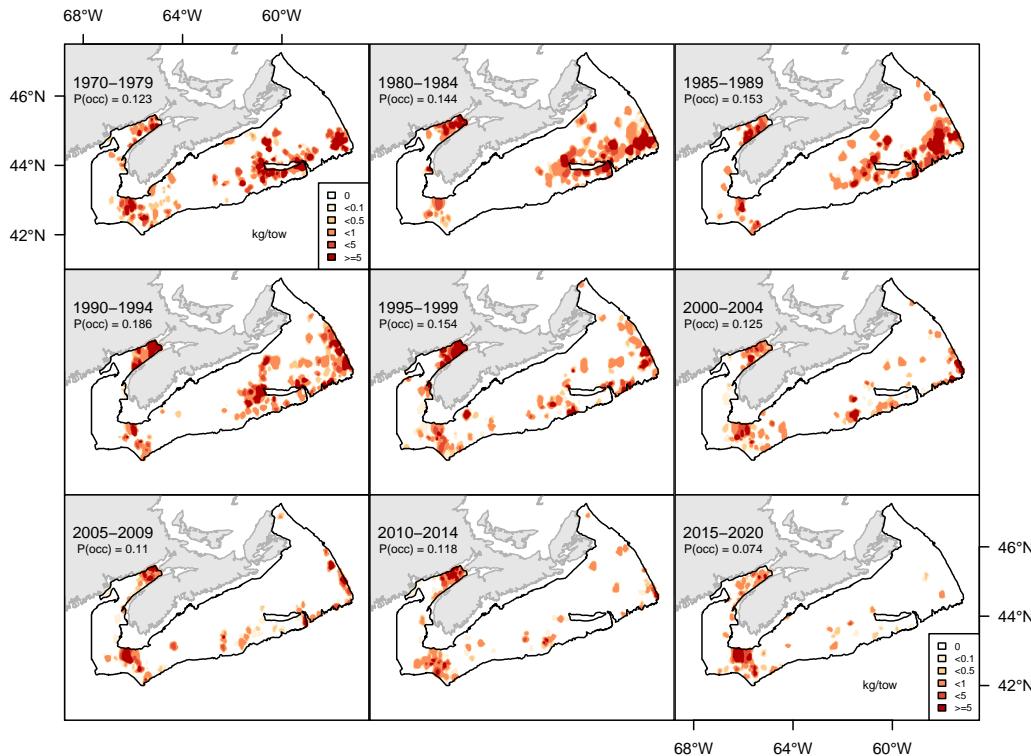


Figure 7.23A. Inverse distance weighted distribution of catch biomass (kg/tow) for Winter skate.

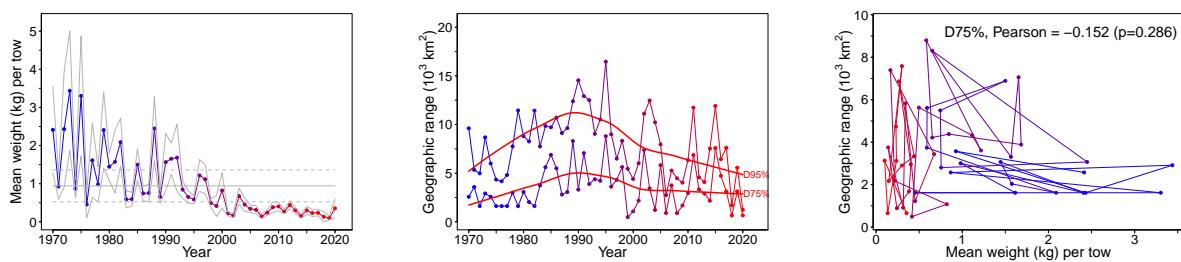


Figure 7.23B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Winter skate.

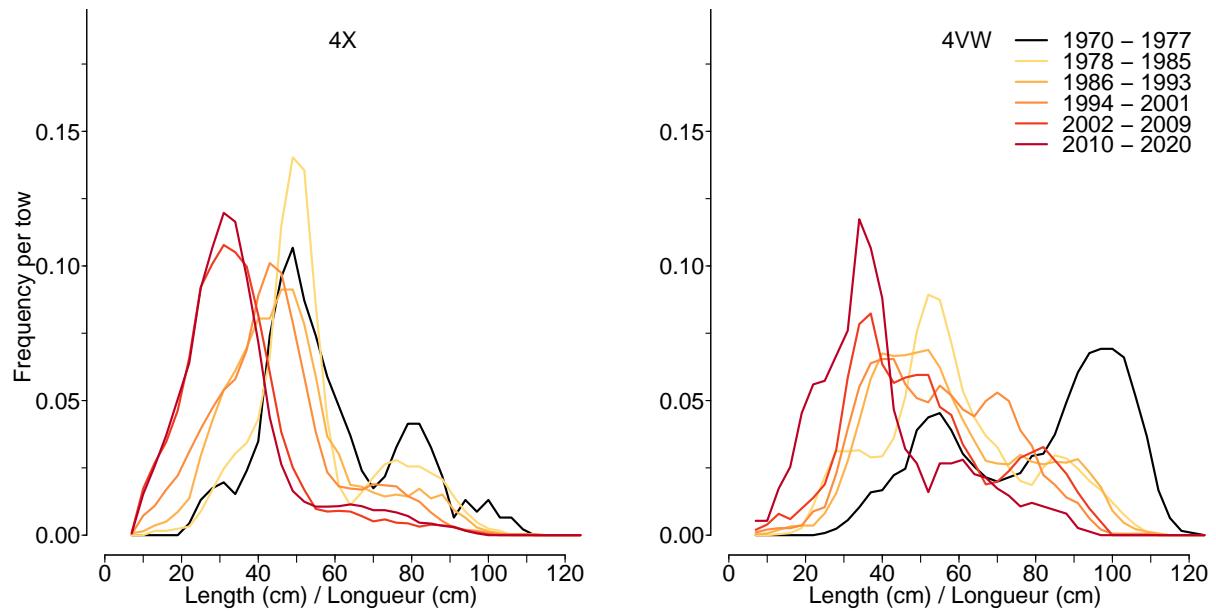


Figure 7.23C. Length frequency distribution in NAFO units 4X and 4VW for Winter skate.

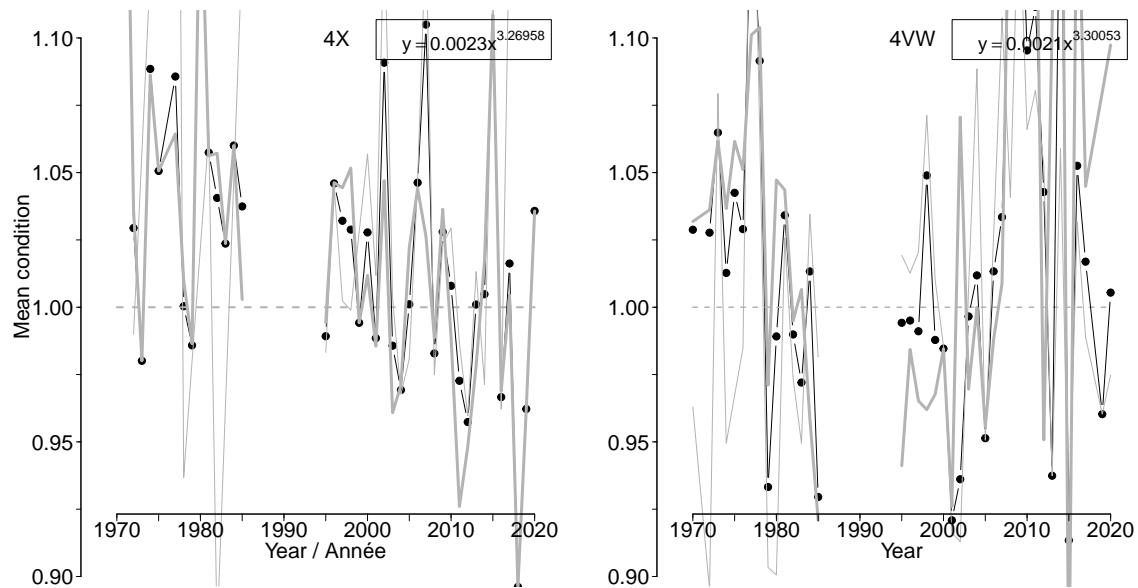


Figure 7.23D. Average fish condition in NAFO units 4X and 4VW for Winter skate.

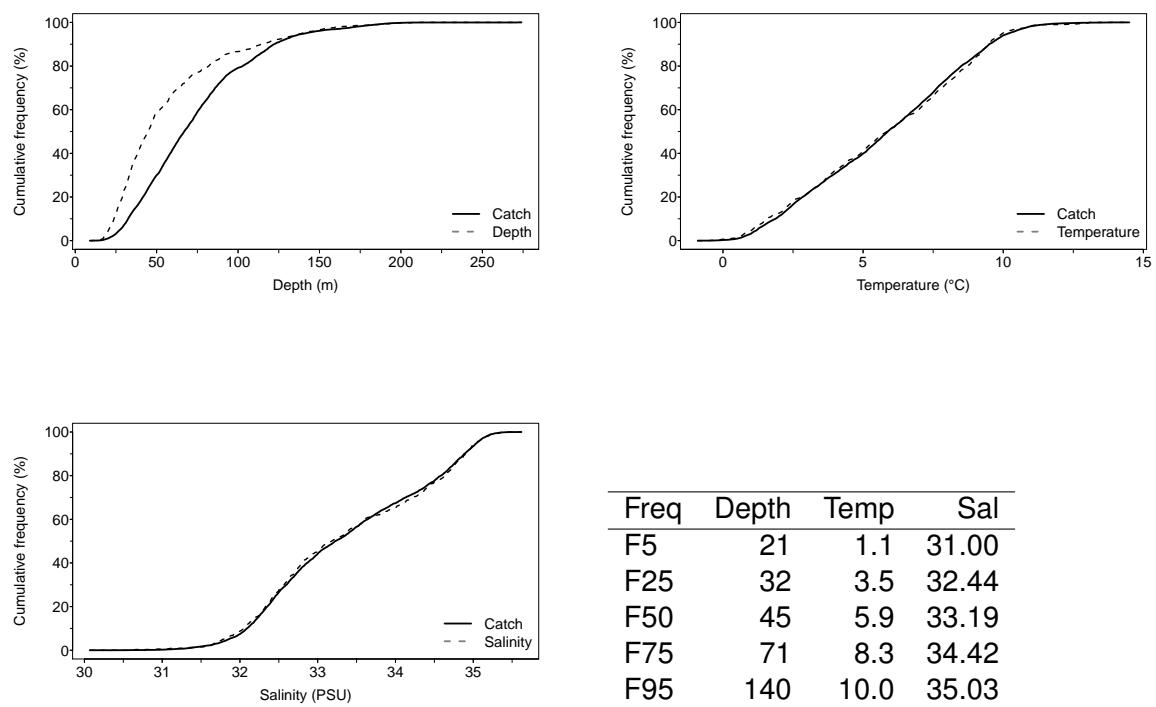


Figure 7.23E. Catch distribution by depth, temperature and salinity of Winter skate.

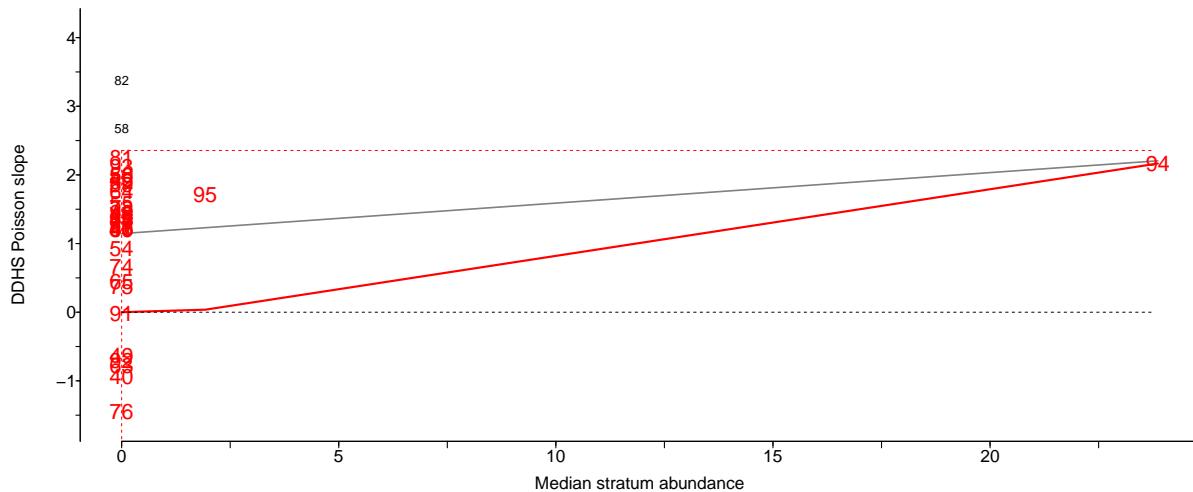


Figure 7.23F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Winter skate.

7.24 Picked dogfish (Aiguillat commun) - species code 220 (category LF)

Scientific name: [Squalus acanthias](#)

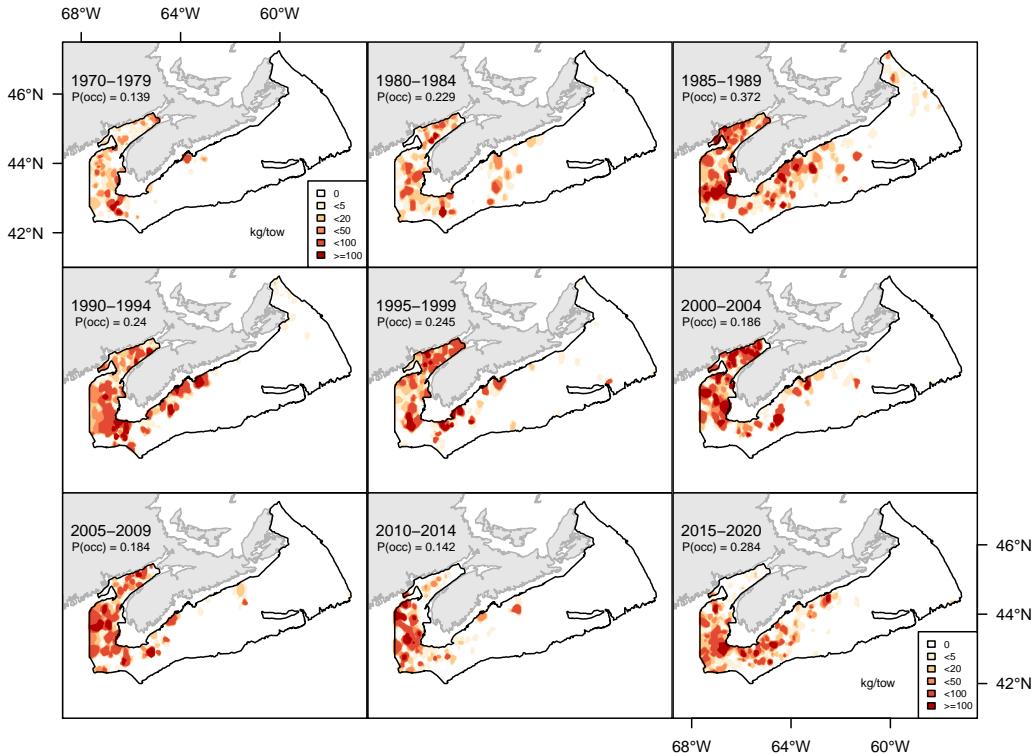


Figure 7.24A. Inverse distance weighted distribution of catch biomass (kg/tow) for Picked dogfish.

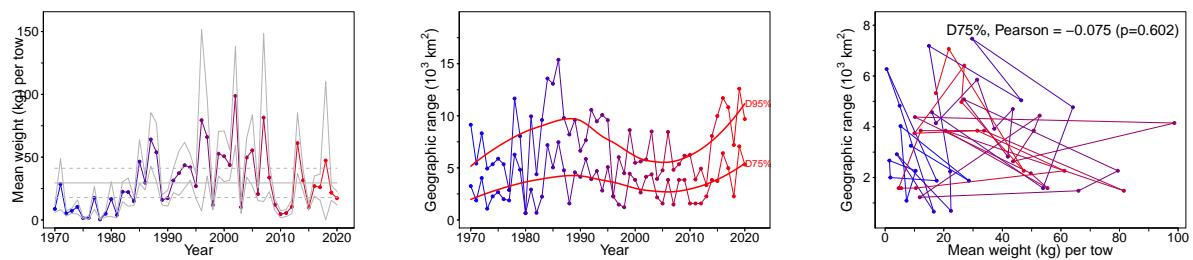


Figure 7.24B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Picked dogfish.

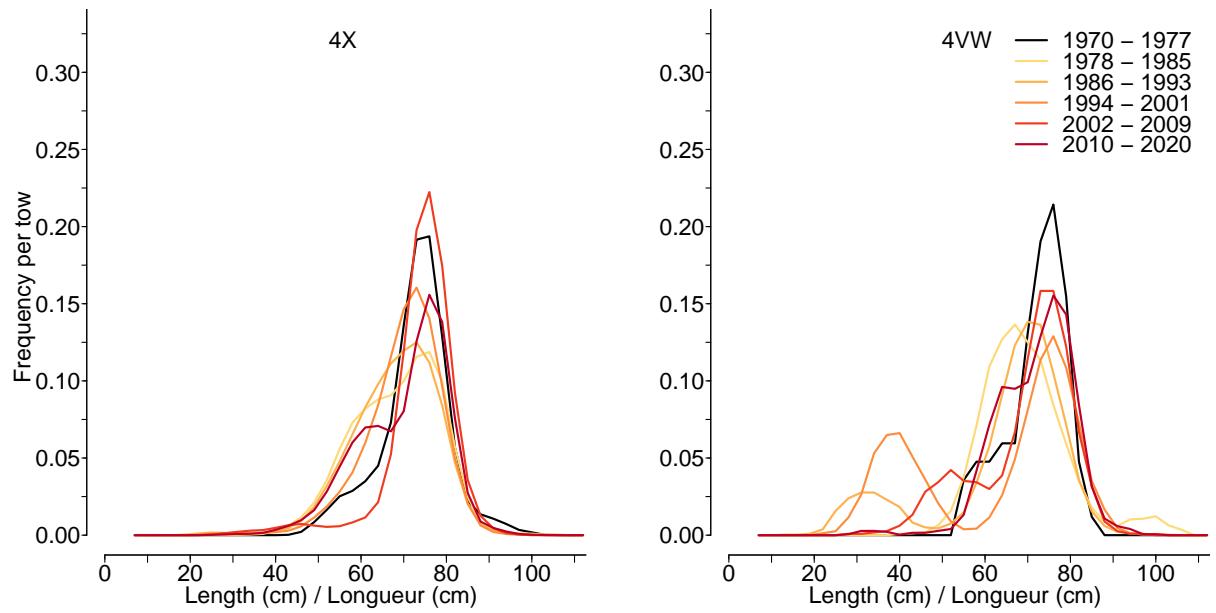


Figure 7.24C. Length frequency distribution in NAFO units 4X and 4VW for Picked dogfish.

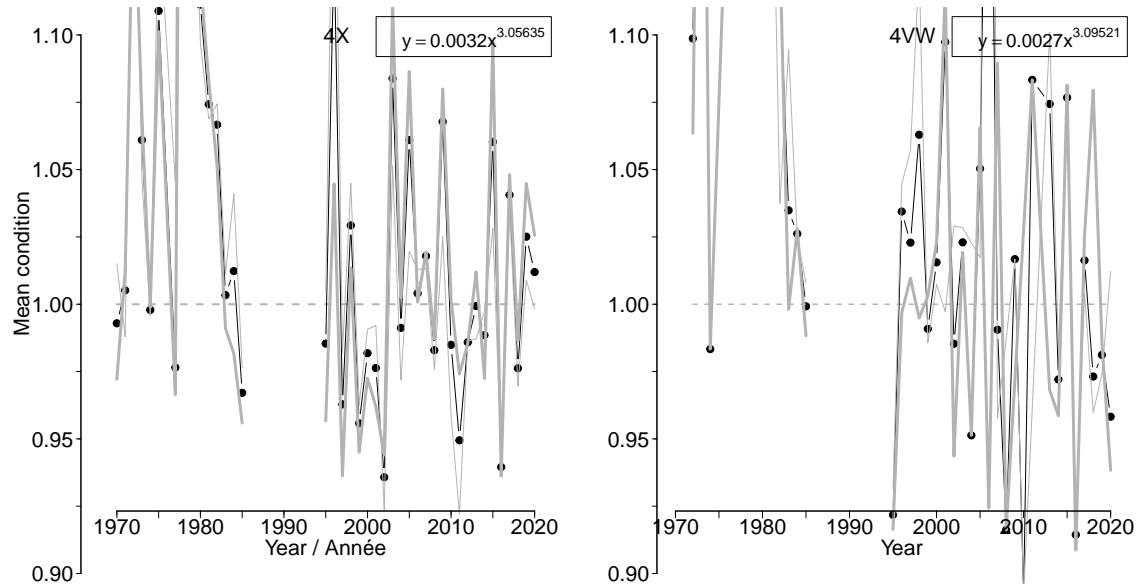


Figure 7.24D. Average fish condition in NAFO units 4X and 4VW for Picked dogfish.

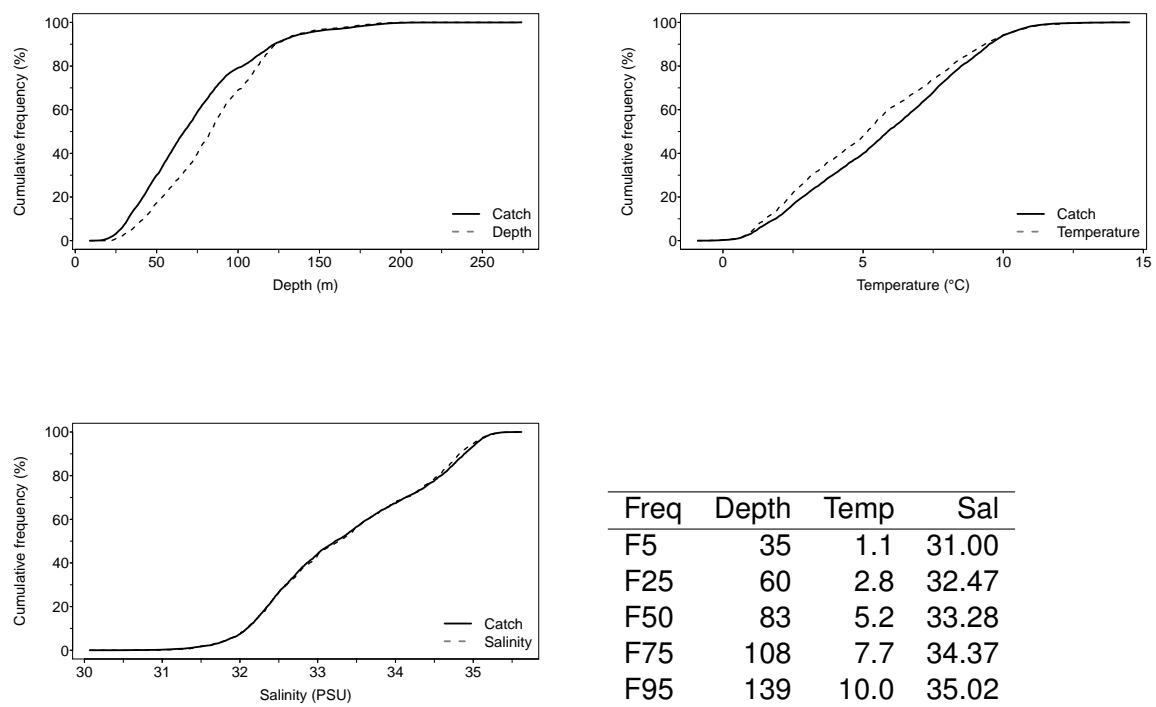


Figure 7.24E. Catch distribution by depth, temperature and salinity of Picked dogfish.

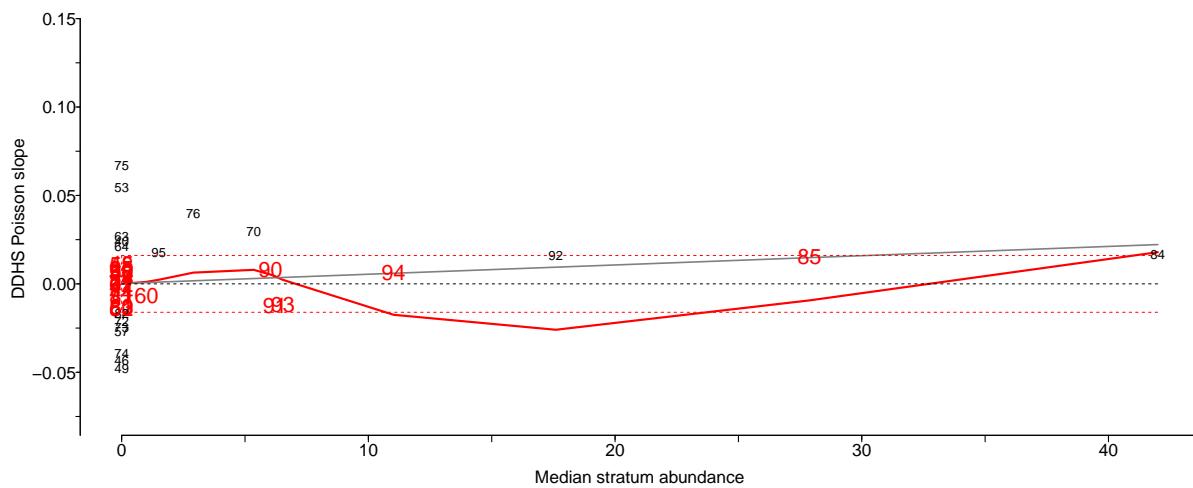


Figure 7.24F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Picked dogfish.

7.25 Northern shortfin squid (*Encornet rouge nordique*) - species code 4511 (category LF)

Scientific name: *Illex illecebrosus*

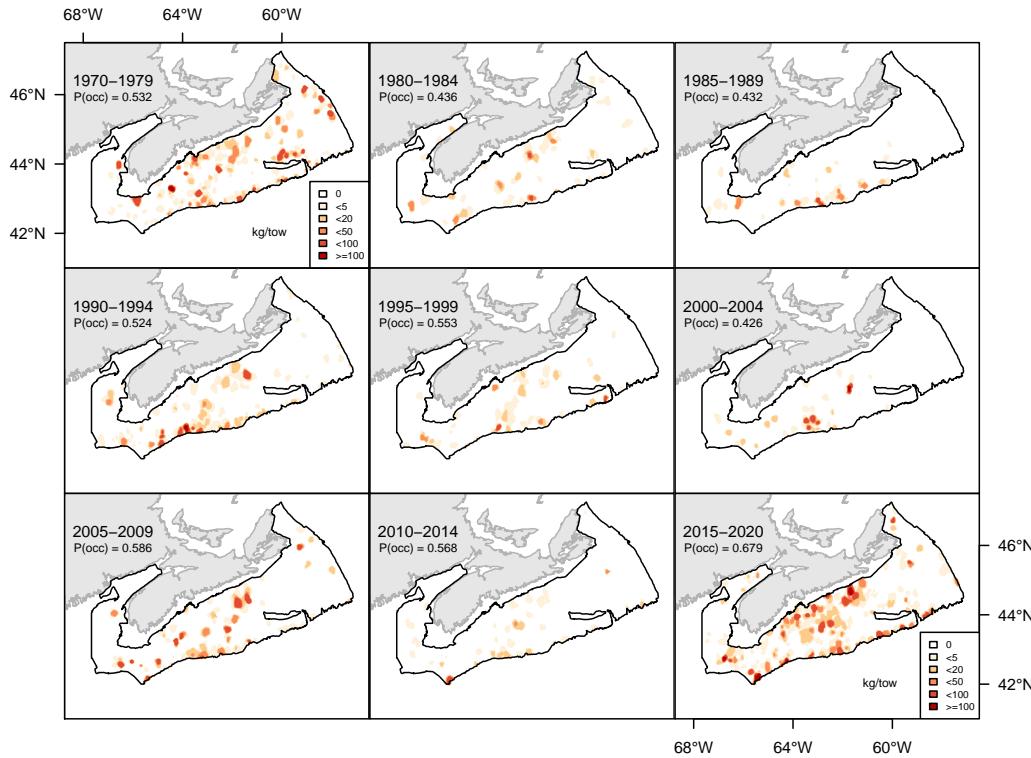


Figure 7.25A. Inverse distance weighted distribution of catch biomass (kg/tow) for Northern shortfin squid.

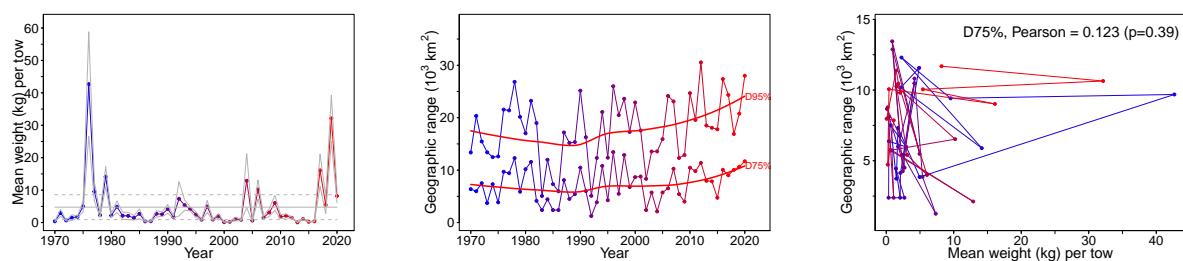


Figure 7.25B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Northern shortfin squid.

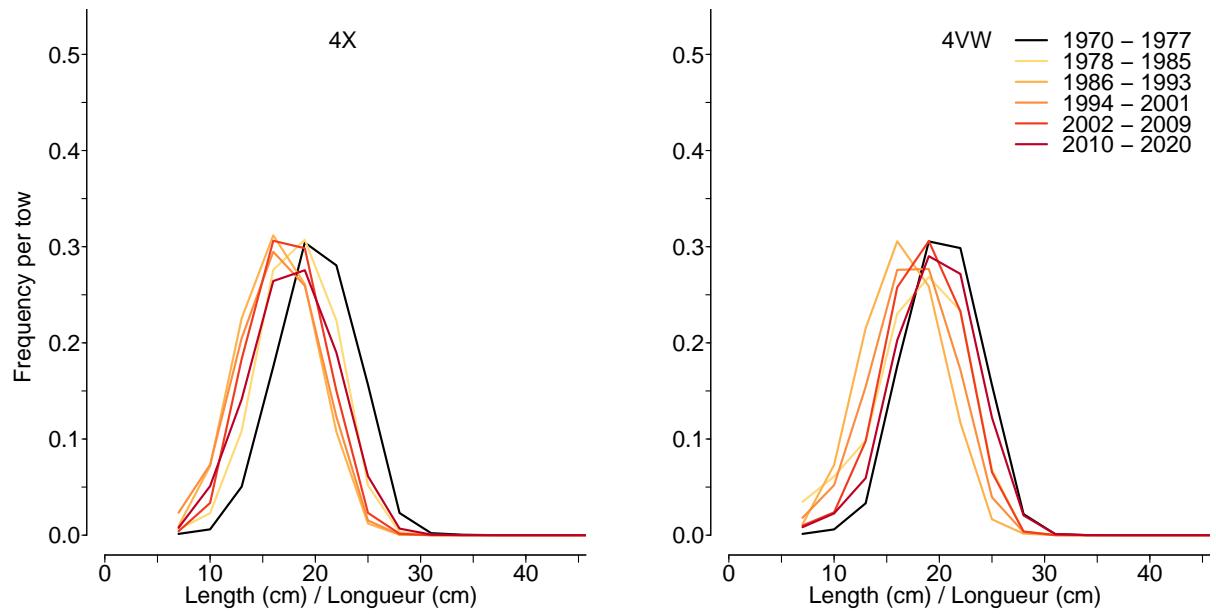


Figure 7.25C. Length frequency distribution in NAFO units 4X and 4VW for Northern shortfin squid.

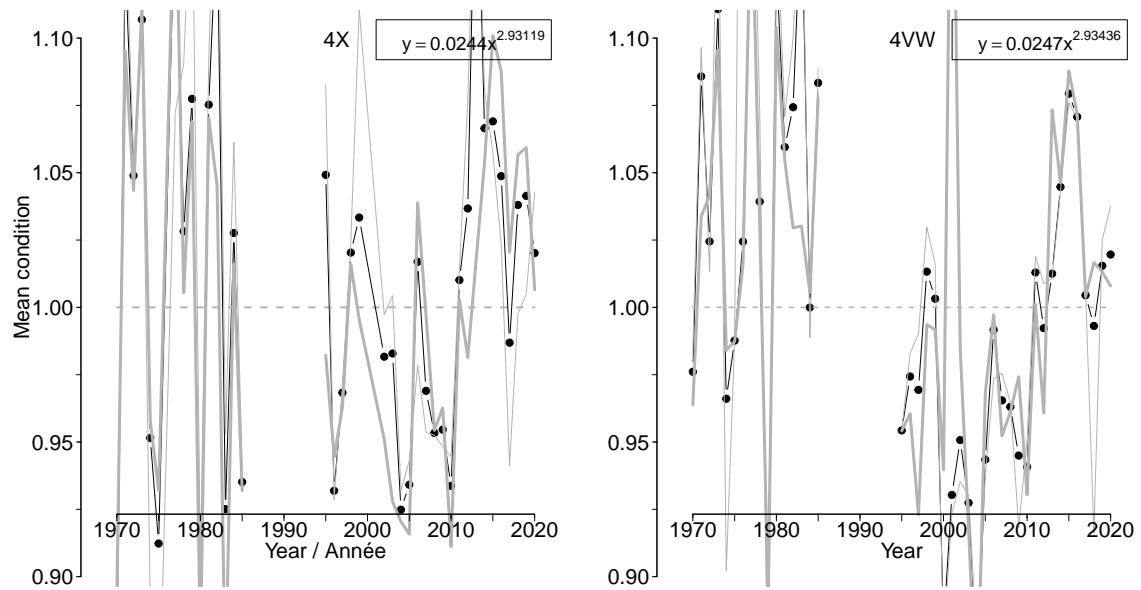


Figure 7.25D. Average fish condition in NAFO units 4X and 4VW for Northern shortfin squid.

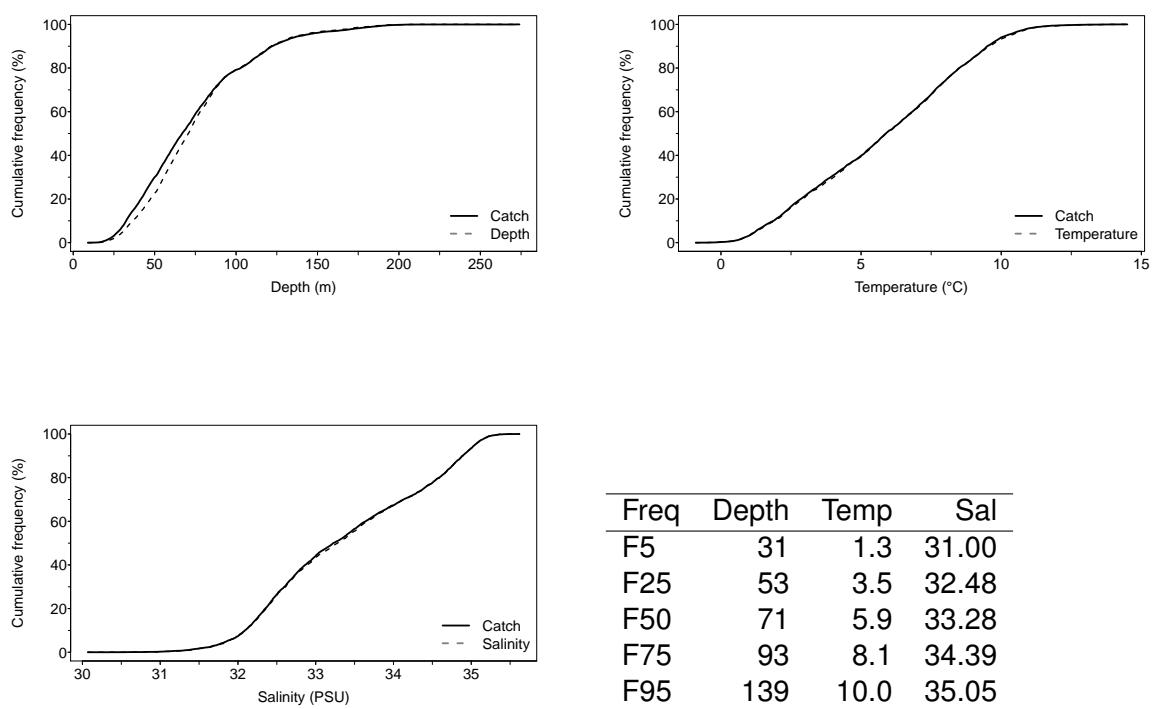


Figure 7.25E. Catch distribution by depth, temperature and salinity of Northern shortfin squid.

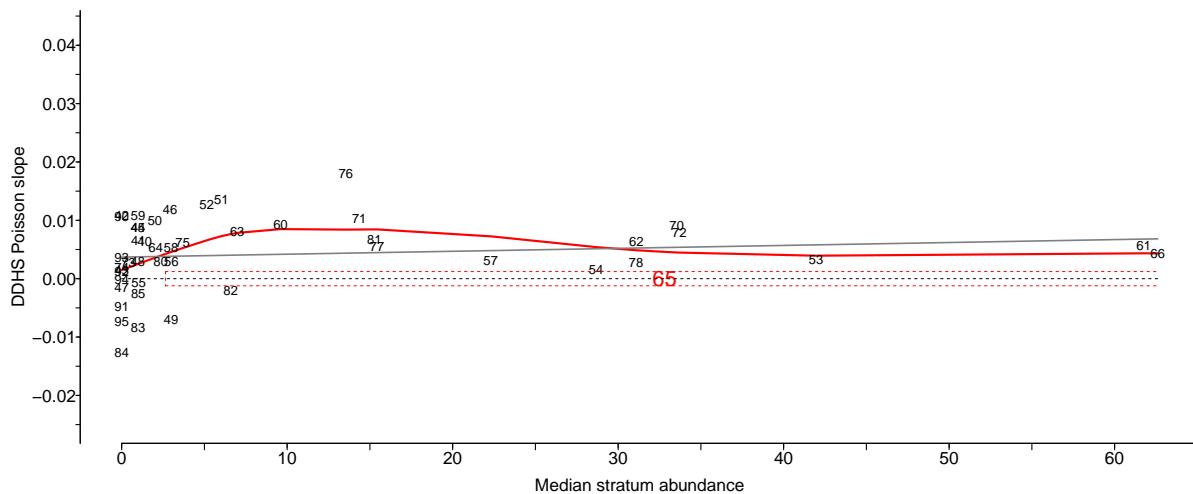


Figure 7.25F. DDHS slopes versus median stratum abundance. The last two digits of each stratum number is shown in the figure for Northern shortfin squid.

7.26 Atlantic hagfish (*Myxine du nord*) - species code 241 (category LI)

Scientific name: *Myxine glutinosa*

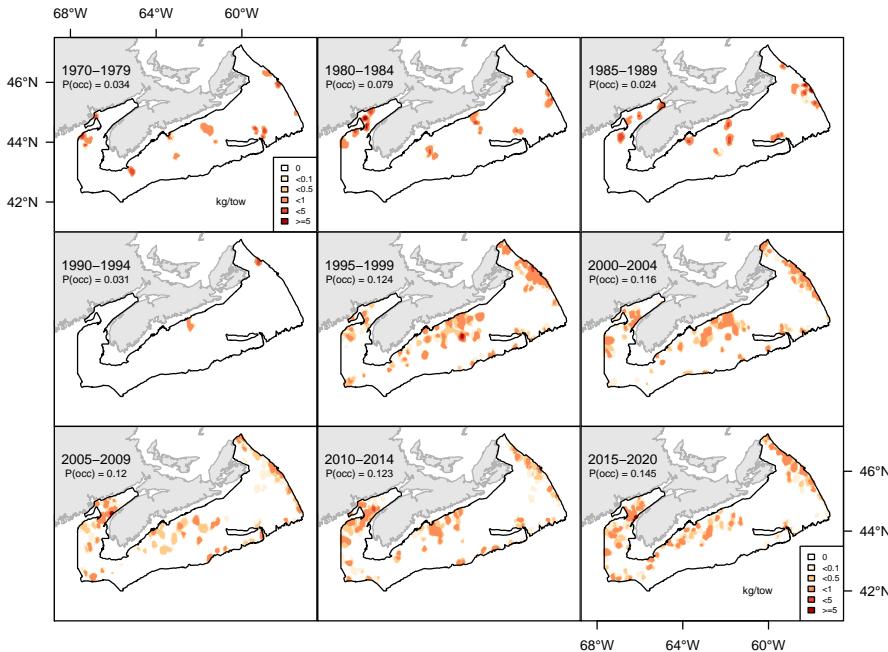


Figure 7.26A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic hagfish.

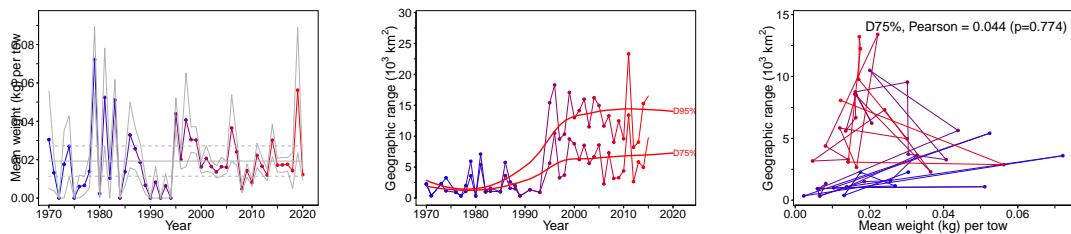


Figure 7.26B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic hagfish.

7.27 Cusk (Brosme) - species code 15 (category LI)

Scientific name: [Brosme brosme](#)

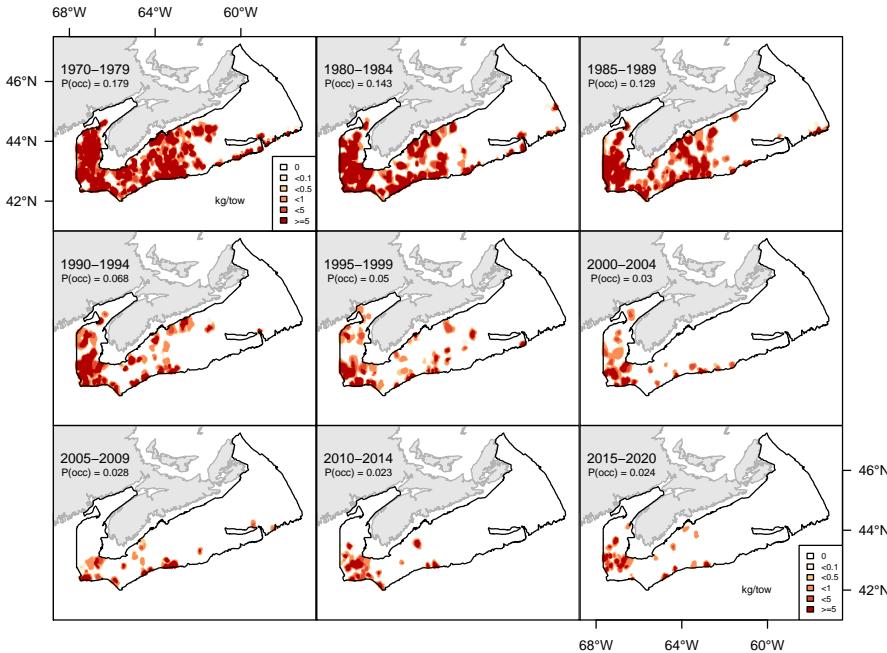


Figure 7.27A. Inverse distance weighted distribution of catch biomass (kg/tow) for Cusk.

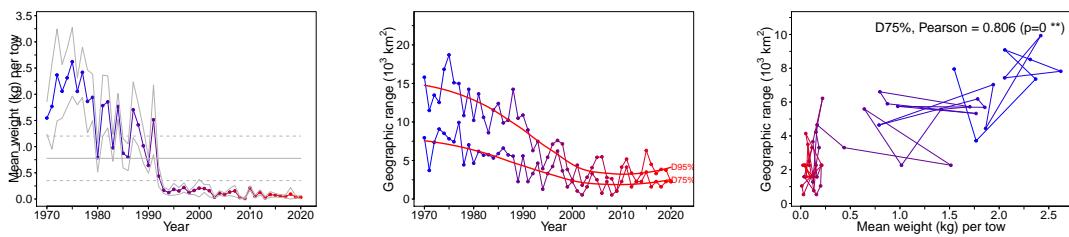


Figure 7.27B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Cusk.

7.28 Greenland halibut (Flétan noir) - species code 31 (category LI)

Scientific name: [Reinhardtius hippoglossoides](#)

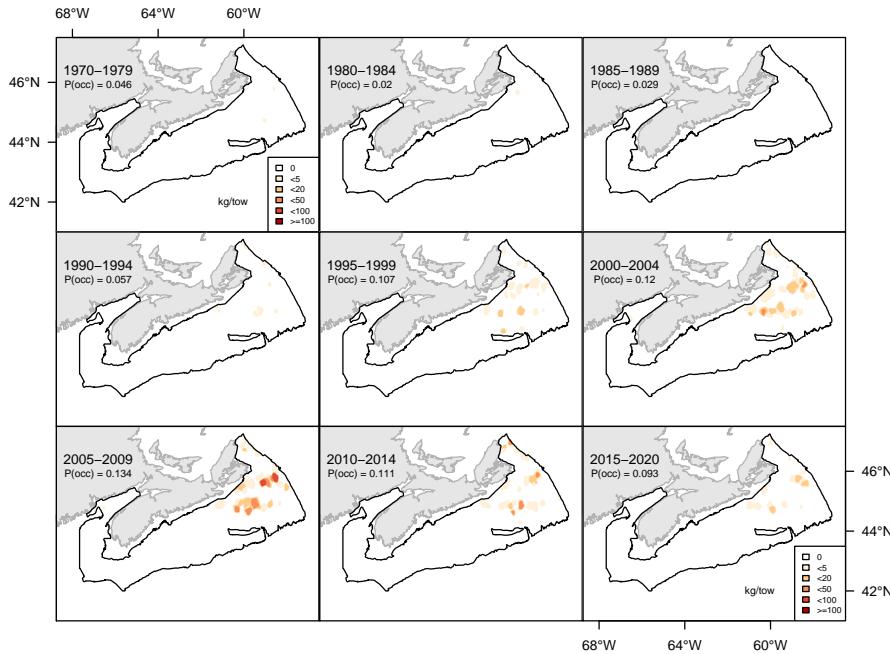


Figure 7.28A. Inverse distance weighted distribution of catch biomass (kg/tow) for Greenland halibut.

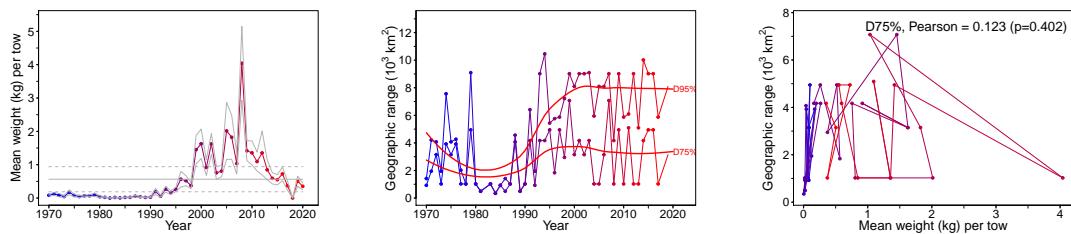


Figure 7.28B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Greenland halibut.

7.29 Gulf Stream flounder (Plie du Gulf Stream) - species code 44 (category LI)

Scientific name: [Citharichthys arctifrons](#)

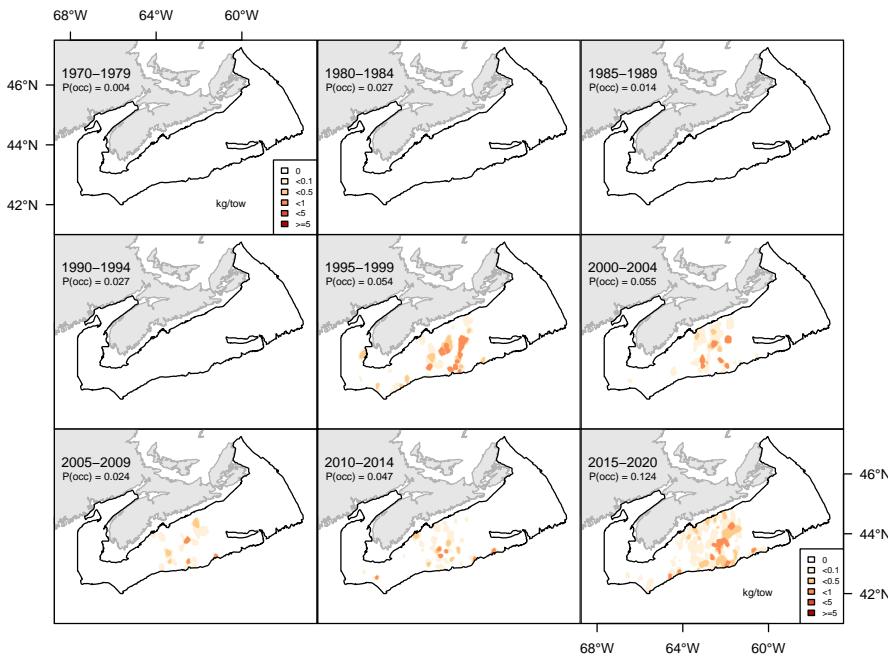


Figure 7.29A. Inverse distance weighted distribution of catch biomass (kg/tow) for Gulf Stream flounder.

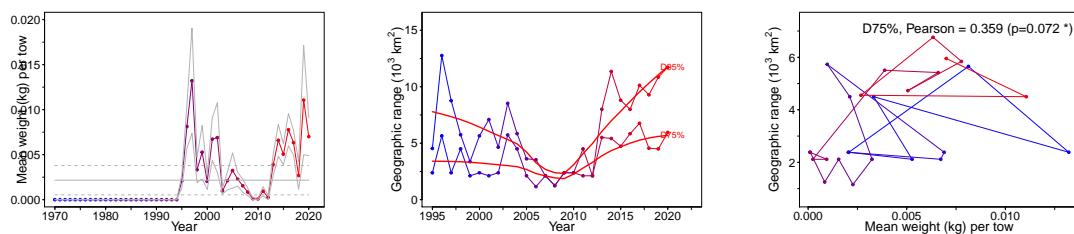


Figure 7.29B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Gulf Stream flounder.

7.30 American shad (*Alose savoureuse*) - species code 61 (category LI)

Scientific name: [Alosa sapidissima](#)

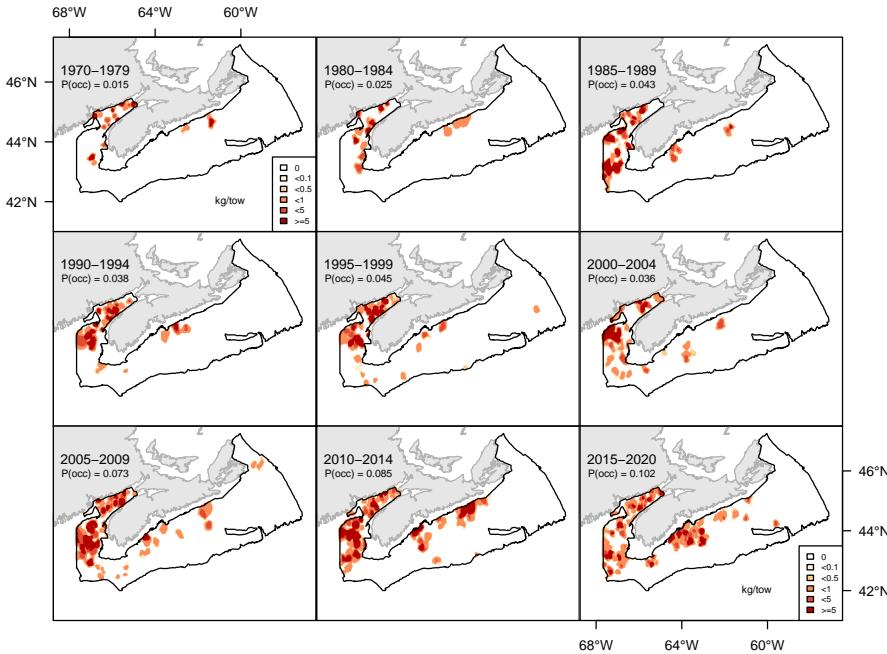


Figure 7.30A. Inverse distance weighted distribution of catch biomass (kg/tow) for American shad.

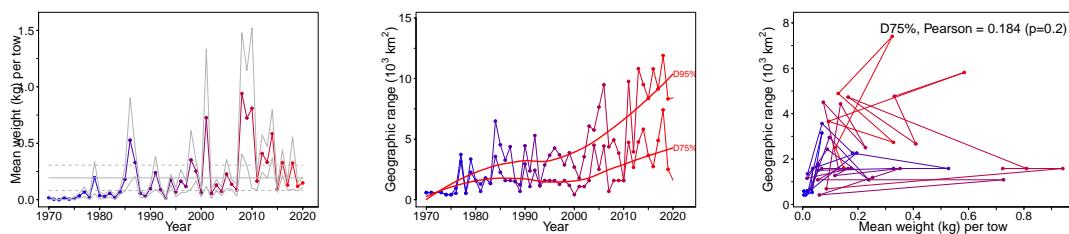


Figure 7.30B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of American shad.

7.31 Alewife (Gaspareau) - species code 62 (category LI)

Scientific name: [Alosa pseudoharengus](#)

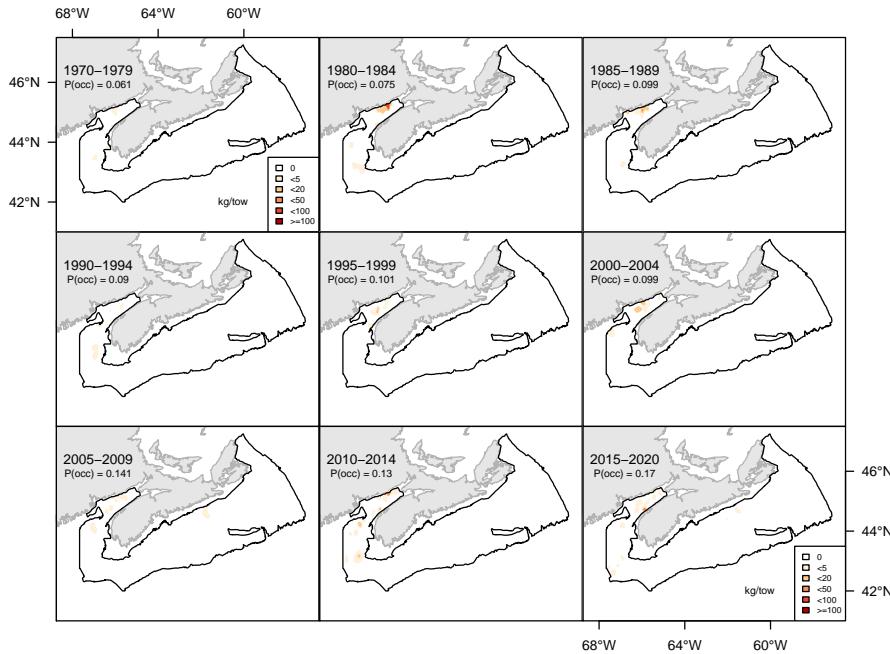


Figure 7.31A. Inverse distance weighted distribution of catch biomass (kg/tow) for Alewife.

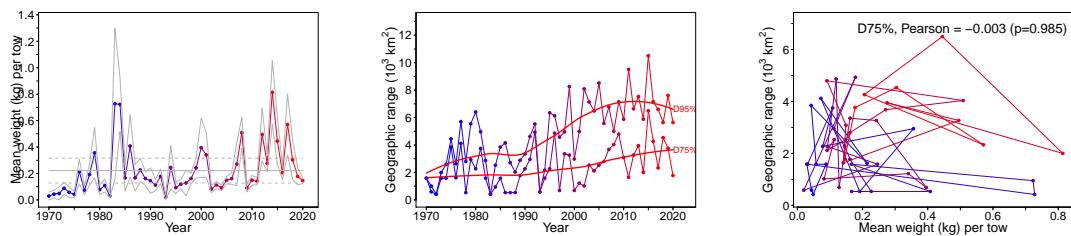


Figure 7.31B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Alewife.

7.32 Capelin (Capelan) - species code 64 (category LI)

Scientific name: [Mallotus villosus](#)

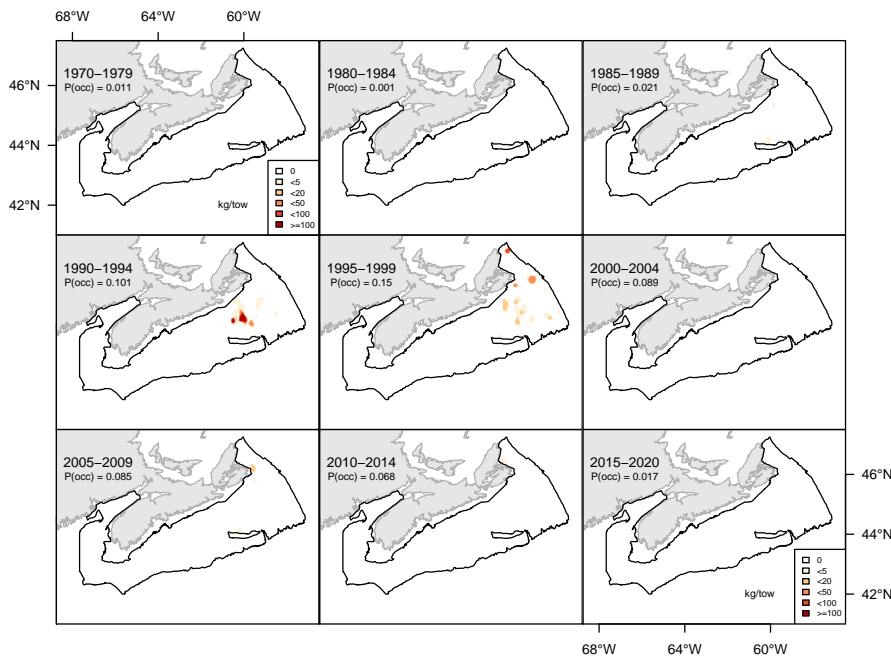


Figure 7.32A. Inverse distance weighted distribution of catch biomass (kg/tow) for Capelin.

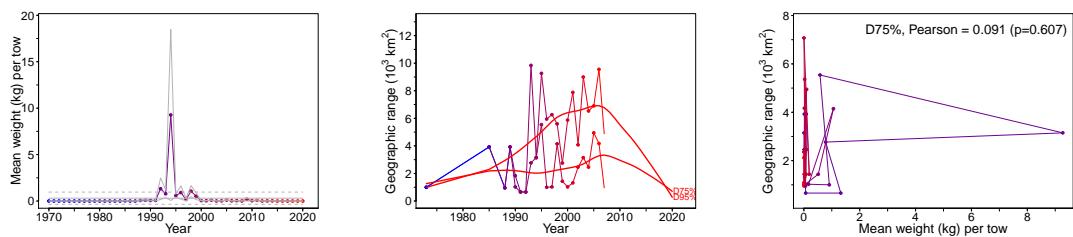


Figure 7.32B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Capelin.

7.33 Atlantic mackerel (*Maquereau commun*) - species code 70 (category LI)

Scientific name: [Scomber scombrus](#)

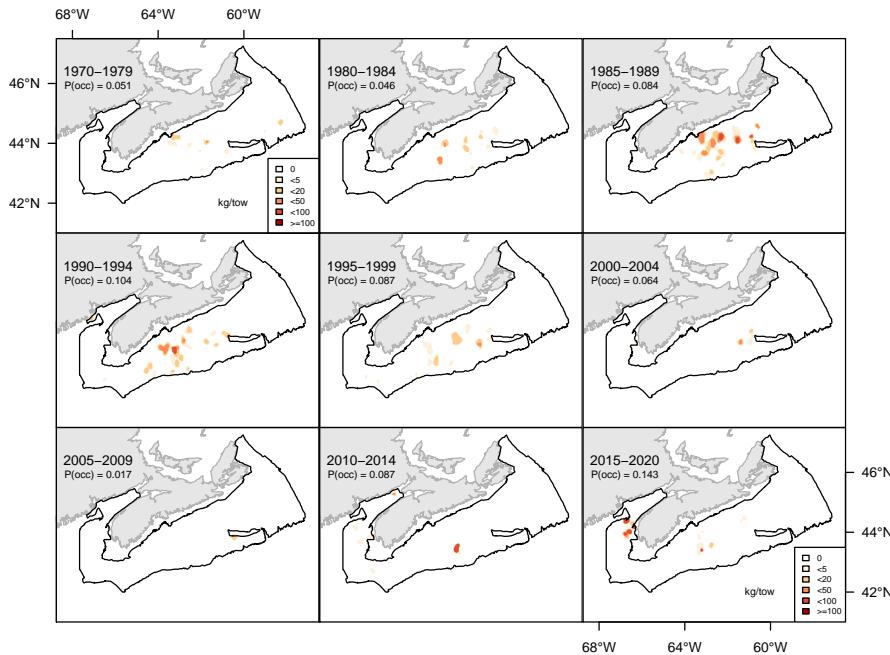


Figure 7.33A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic mackerel.

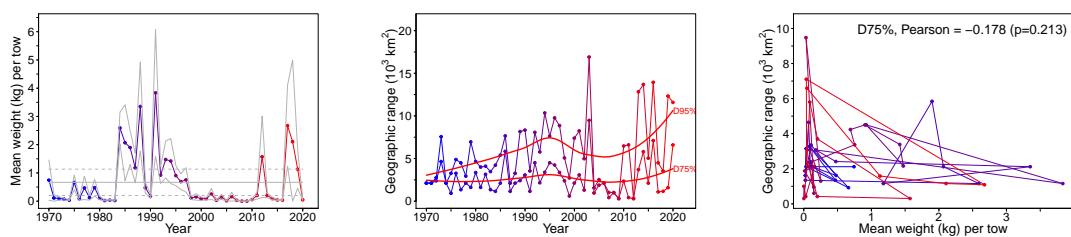


Figure 7.33B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic mackerel.

7.34 Longfin hake (Merluche à longues nageoires) - species code 112 (category LI)

Scientific name: [Phycis chesteri](#)

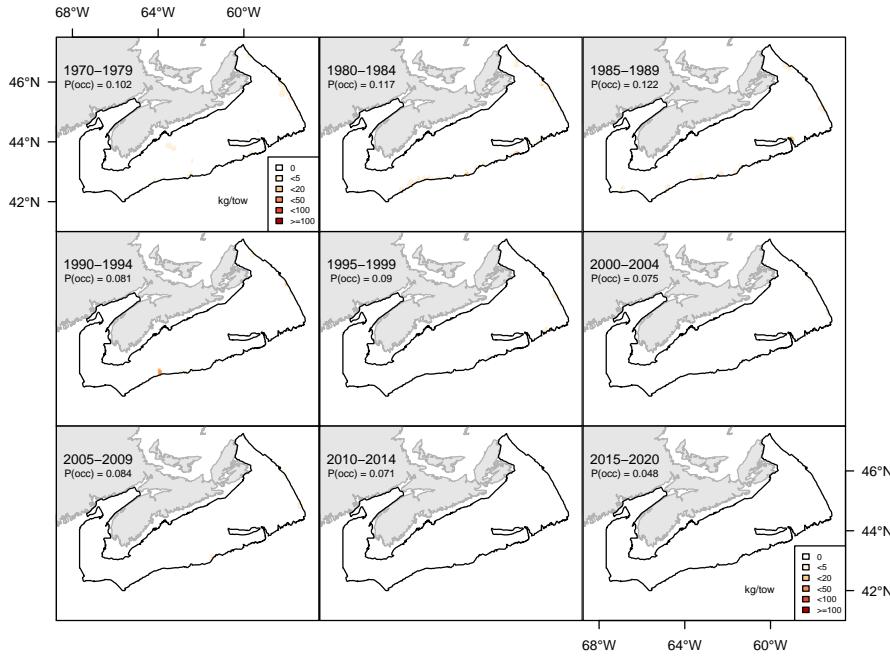


Figure 7.34A. Inverse distance weighted distribution of catch biomass (kg/tow) for Longfin hake.

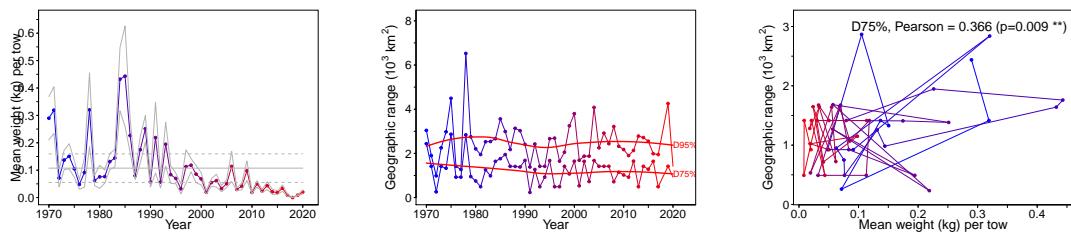


Figure 7.34B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Longfin hake.

7.35 Fourbeard rockling (Motelle à quatre barbillons) - species code 114 (category LI)

Scientific name: [Enchelyopus cimbrius](#)

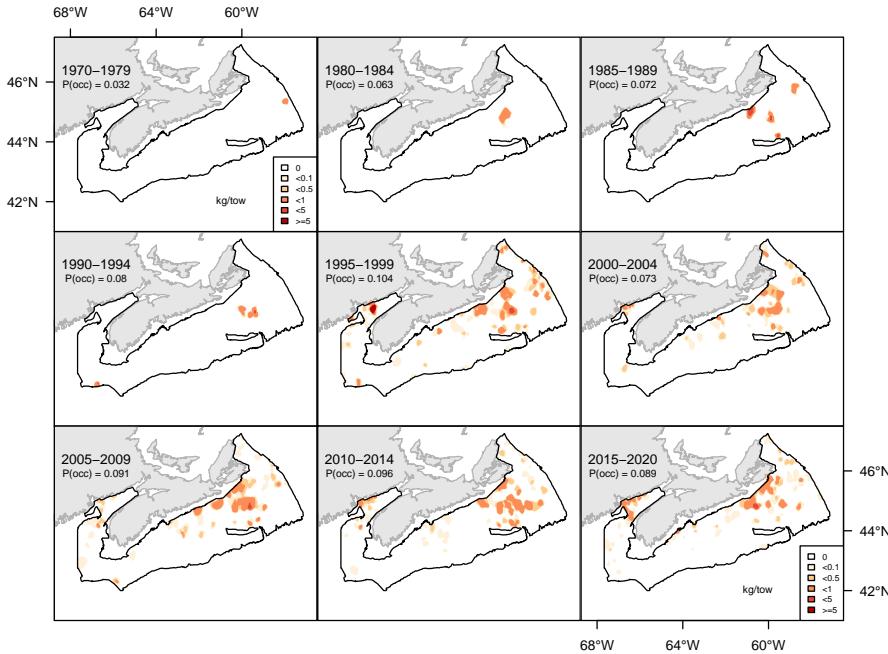


Figure 7.35A. Inverse distance weighted distribution of catch biomass (kg/tow) for Fourbeard rockling.

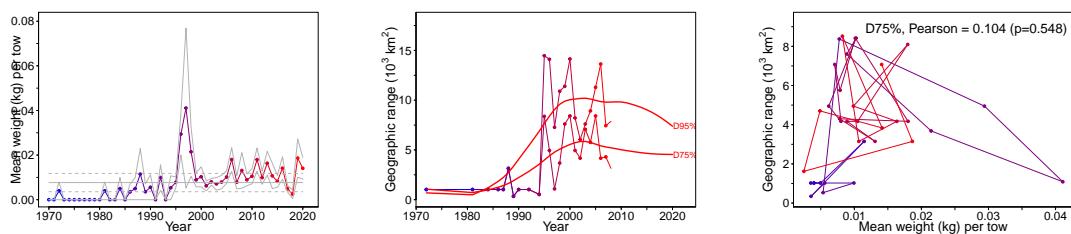


Figure 7.35B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Fourbeard rockling.

7.36 Blackbelly rosefish (Sébaste chèvre) - species code 123 (category LI)

Scientific name: [Helicolenus dactylopterus](#)

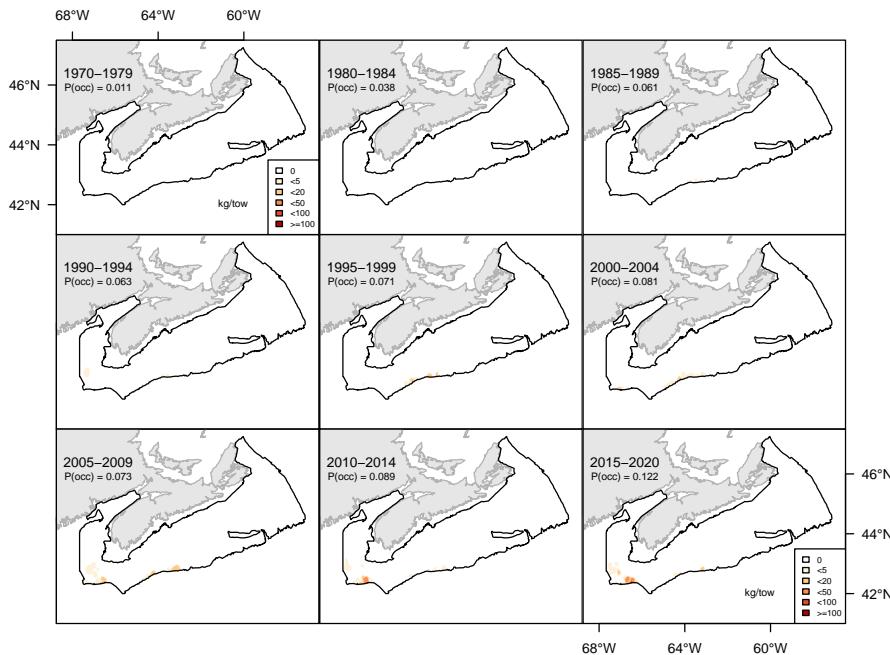


Figure 7.36A. Inverse distance weighted distribution of catch biomass (kg/tow) for Blackbelly rosefish.

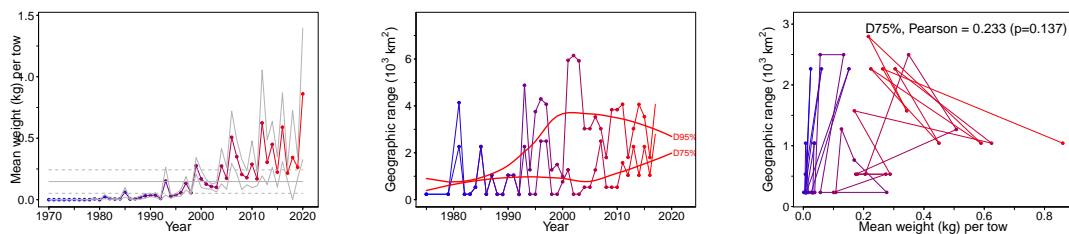


Figure 7.36B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Blackbelly rosefish.

7.37 Greater argentine (Grande argentine) - species code 160 (category LI)

Scientific name: [Argentina silus](#)

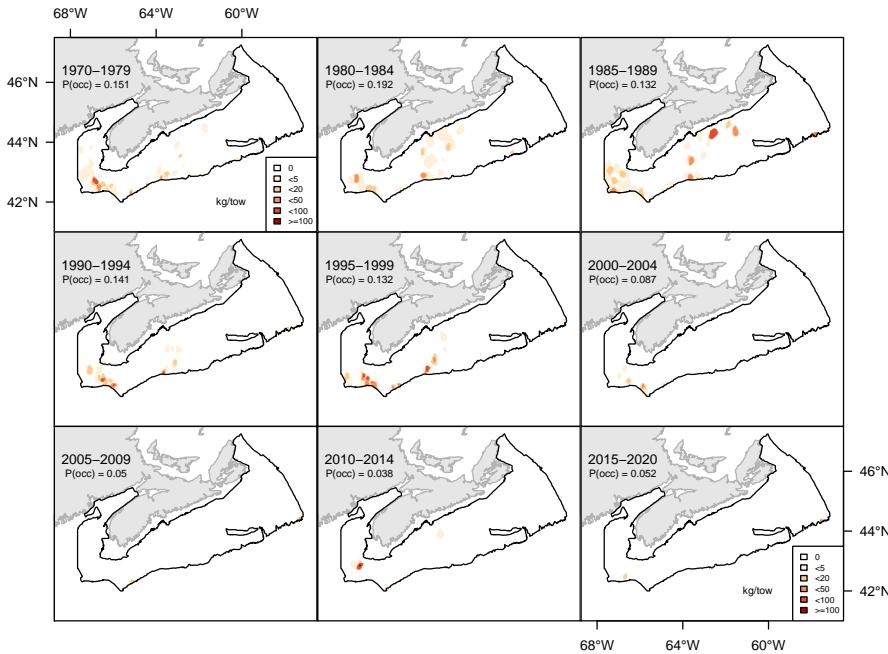


Figure 7.37A. Inverse distance weighted distribution of catch biomass (kg/tow) for Greater argentine.

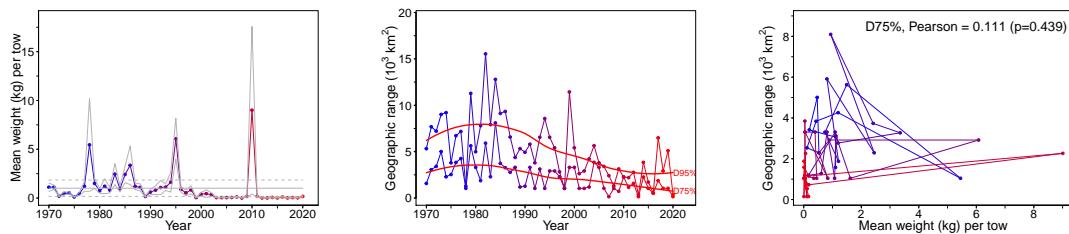


Figure 7.37B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Greater argentine.

7.38 Arctic hookear sculpin (*Hameçon neigeux*) - species code 306 (category LI)

Scientific name: [Artediellus uncinatus](#)

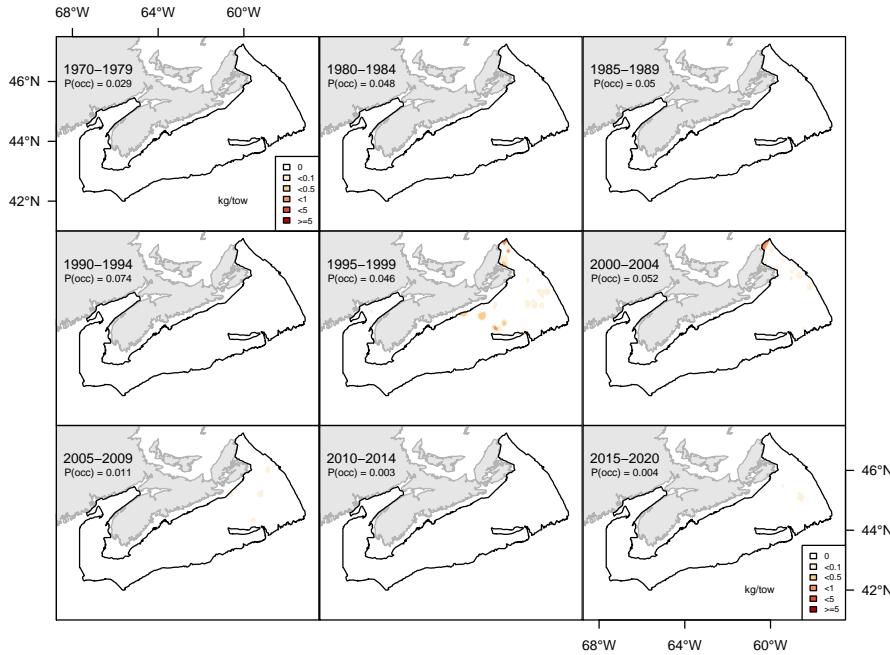


Figure 7.38A. Inverse distance weighted distribution of catch biomass (kg/tow) for Arctic hookear sculpin.

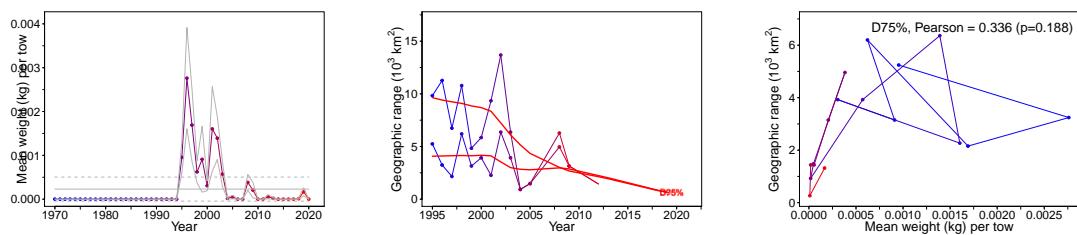


Figure 7.38B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Arctic hookear sculpin.

7.39 Atlantic poacher (*Agone atlantique*) - species code 350 (category LI)

Scientific name: [Leptagonus decagonus](#)

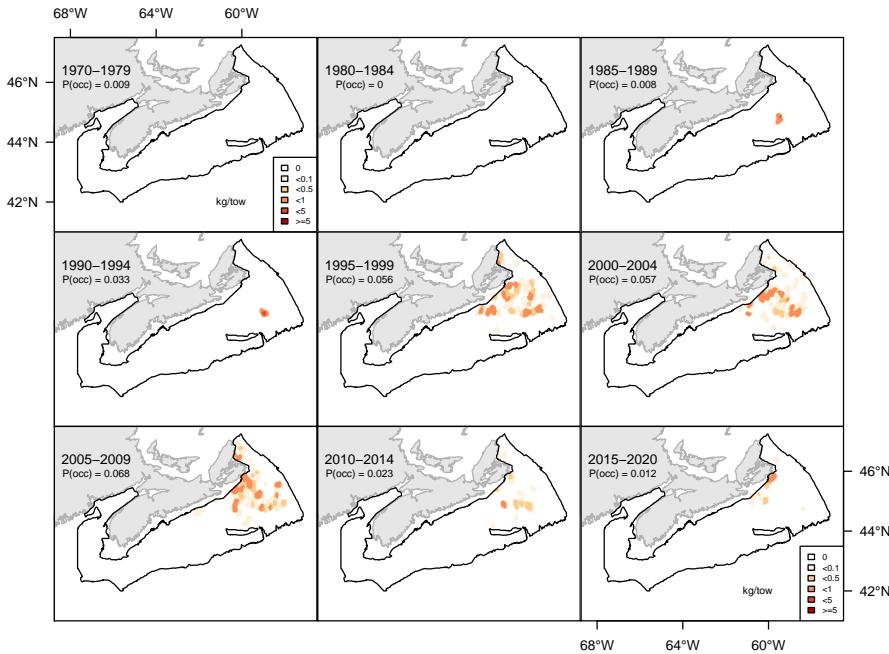


Figure 7.39A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic poacher.

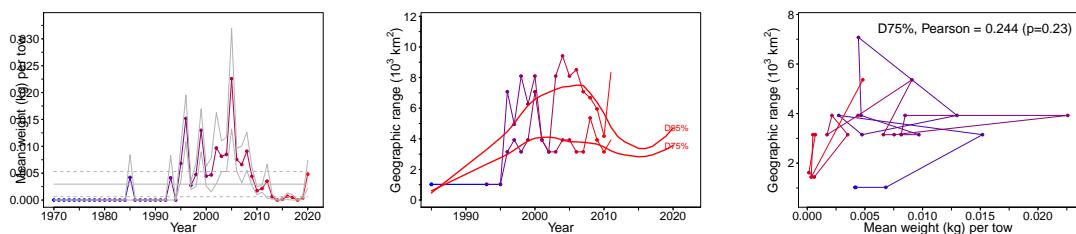


Figure 7.39B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic poacher.

7.40 Marlin-spike grenadier (Grenadier du Grand Banc) - species code 410 (category LI)

Scientific name: [Nezumia bairdii](#)

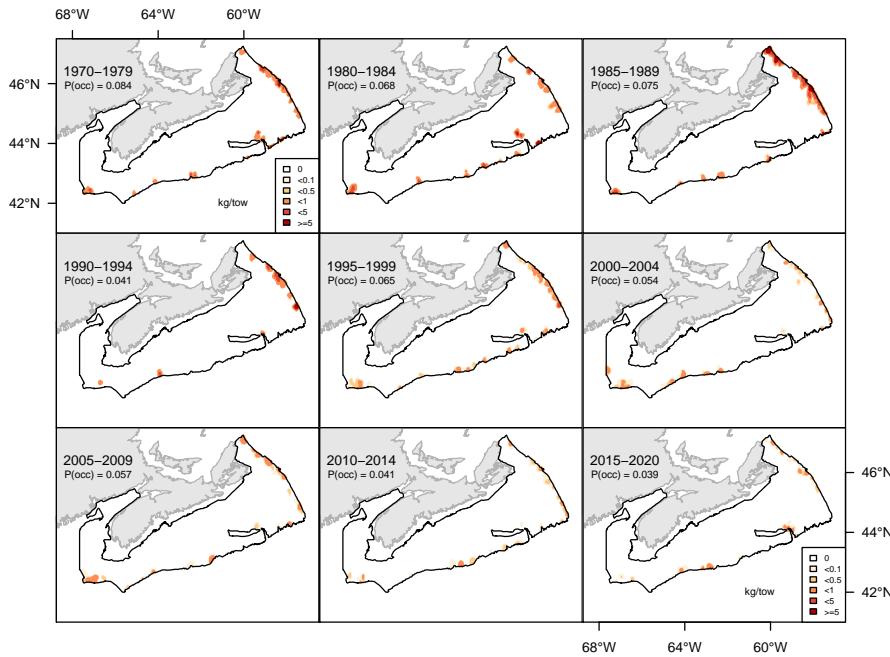


Figure 7.40A. Inverse distance weighted distribution of catch biomass (kg/tow) for Marlin-spike grenadier.

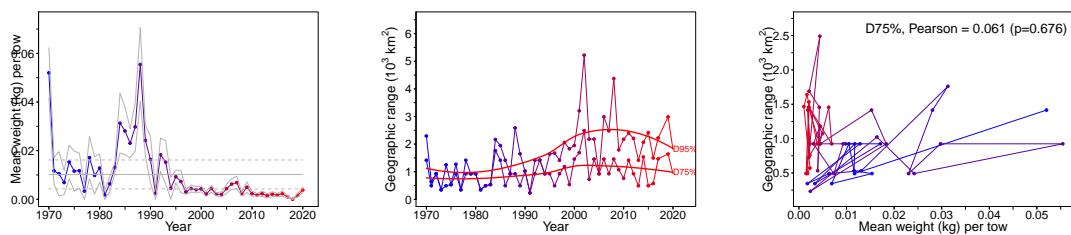


Figure 7.40B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Marlin-spike grenadier.

7.41 Lumpfish (Lompe) - species code 501 (category LI)

Scientific name: [Cyclopterus lumpus](#)

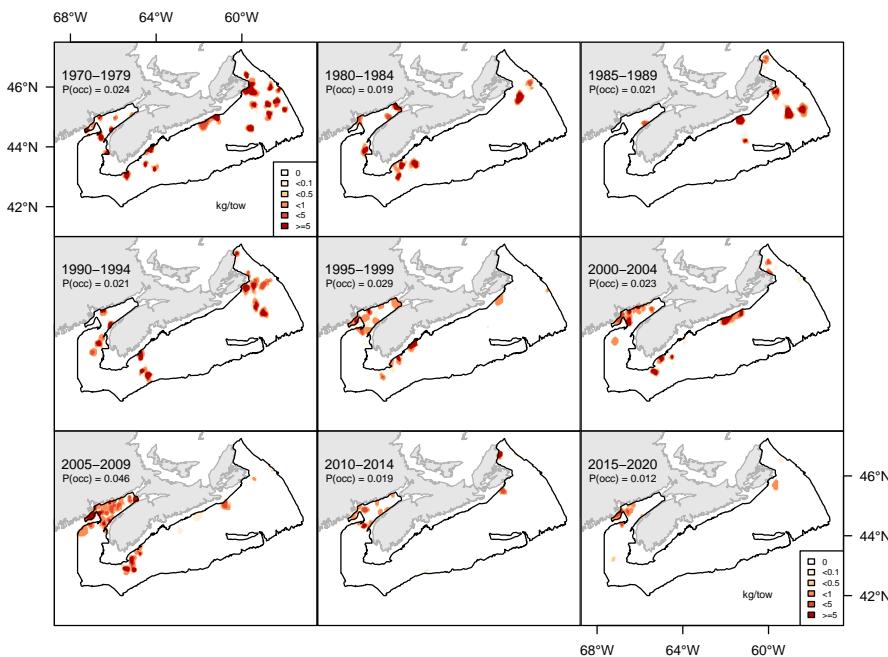


Figure 7.41A. Inverse distance weighted distribution of catch biomass (kg/tow) for Lumpfish.

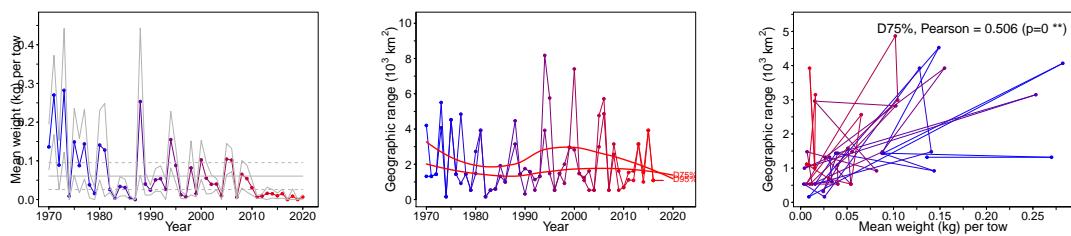


Figure 7.41B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Lumpfish.

7.42 Atlantic spiny lumpsucker (Petite poule de mer atlantique) - species code 502 (category LI)

Scientific name: [Eumicrotremus spinosus](#)

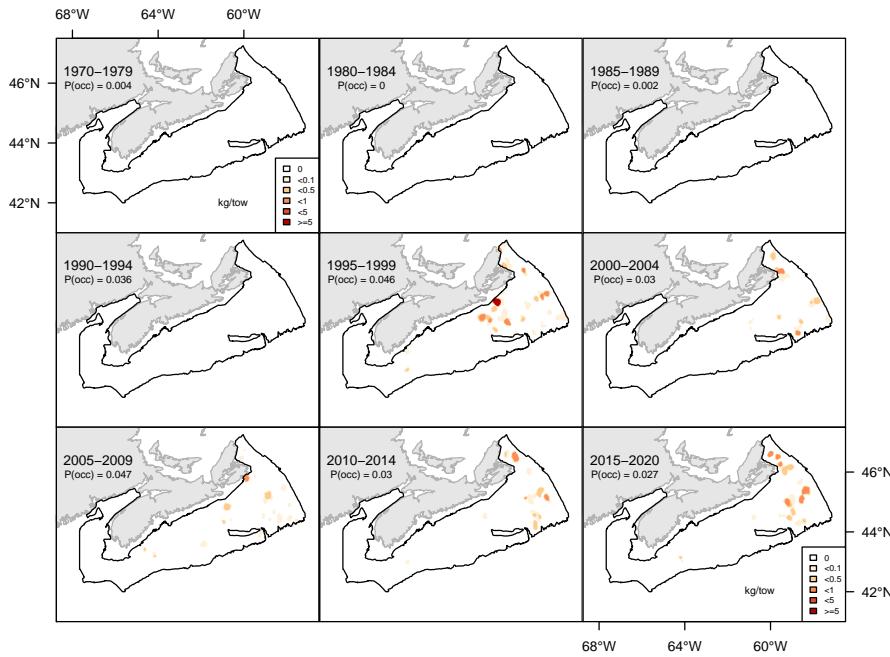


Figure 7.42A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic spiny lumpsucker.

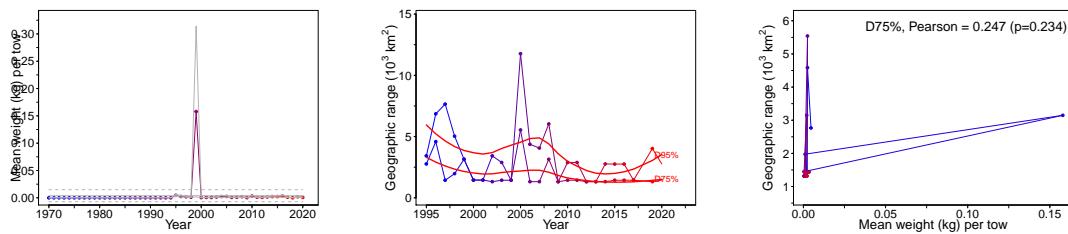


Figure 7.42B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic spiny lumpsucker.

7.43 Sand lance (Lançon) - species code 610 (category LI)

Scientific name: [Ammodytes dubius](#)

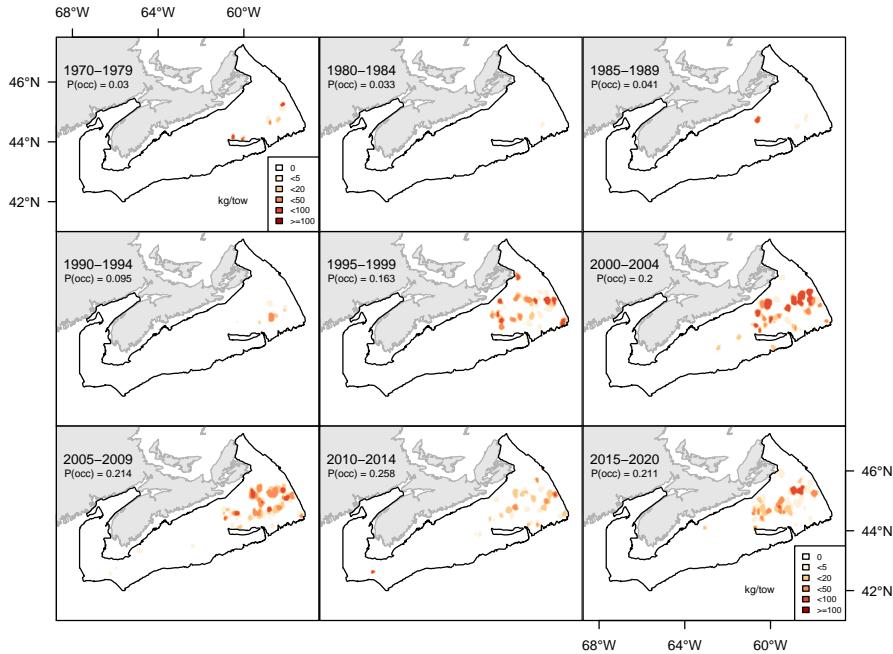


Figure 7.43A. Inverse distance weighted distribution of catch biomass (kg/tow) for Sand lance.

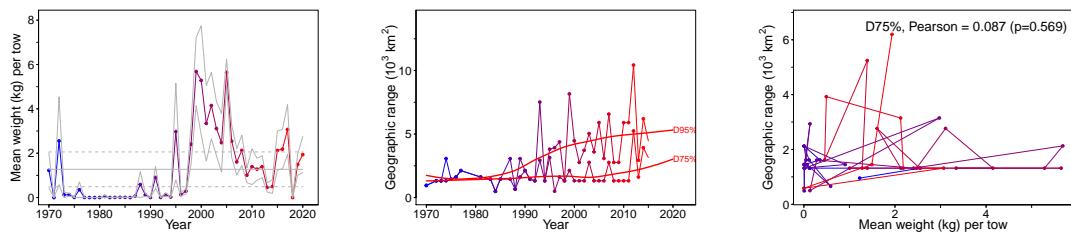


Figure 7.43B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Sand lance.

7.44 Snakeblenny (Lompénie-serpent) - species code 622 (category LI)

Scientific name: [Lumpenus lampretaeformis](#)

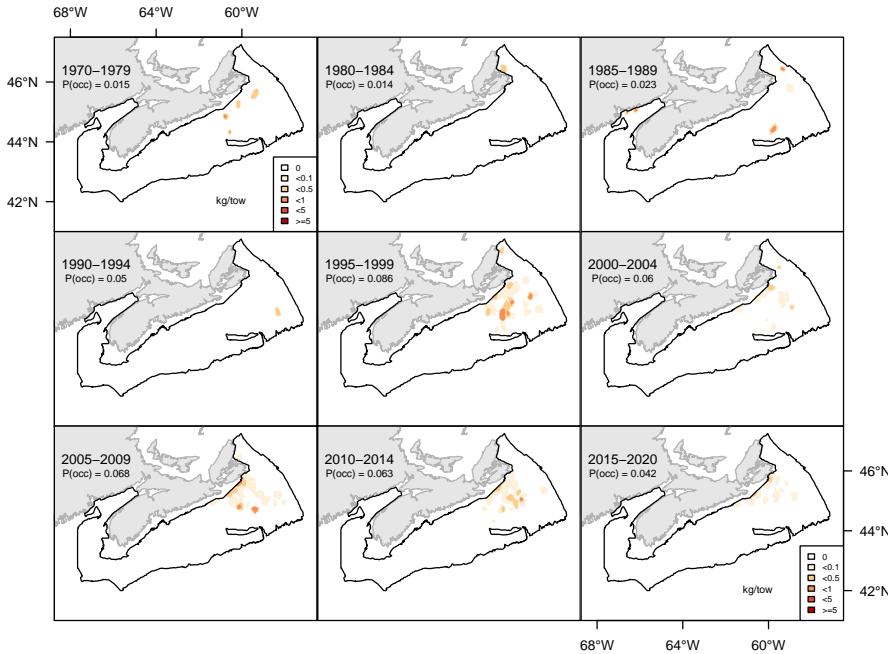


Figure 7.44A. Inverse distance weighted distribution of catch biomass (kg/tow) for Snakeblenny.

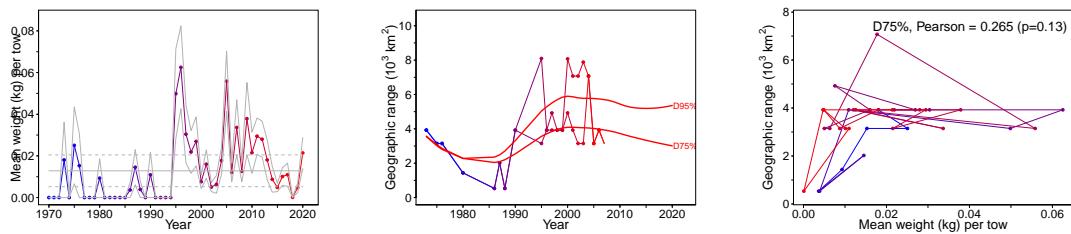


Figure 7.44B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Snakeblenny.

7.45 Daubed shanny (Lompénie tachetée) - species code 623 (category LI)

Scientific name: [Leptoclinus maculatus](#)

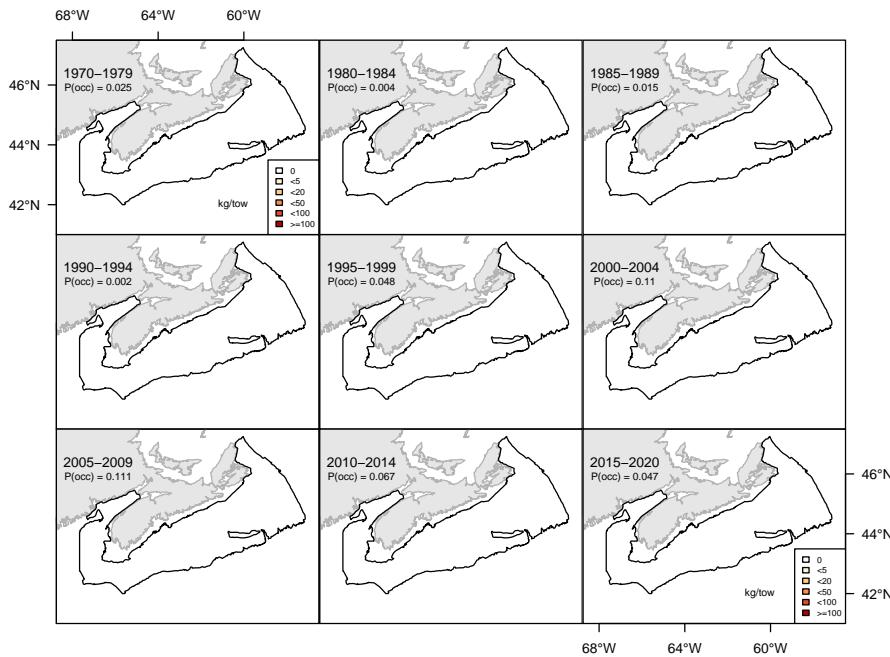


Figure 7.45A. Inverse distance weighted distribution of catch biomass (kg/tow) for Daubed shanny.

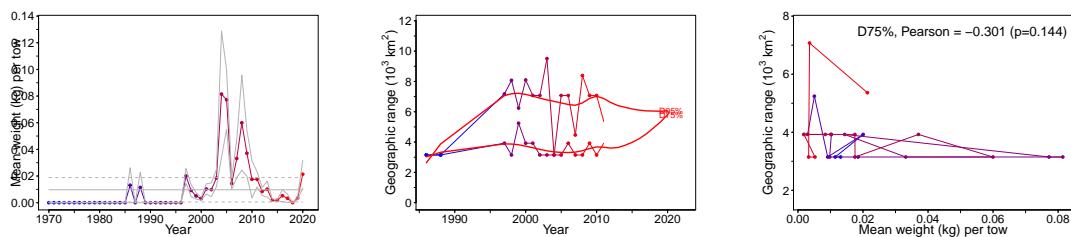


Figure 7.45B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Daubed shanny.

7.46 Vahl's eelpout (*Lycodes vahlii*) - species code 647 (category LI)

Scientific name: [Lycodes vahlii](#)

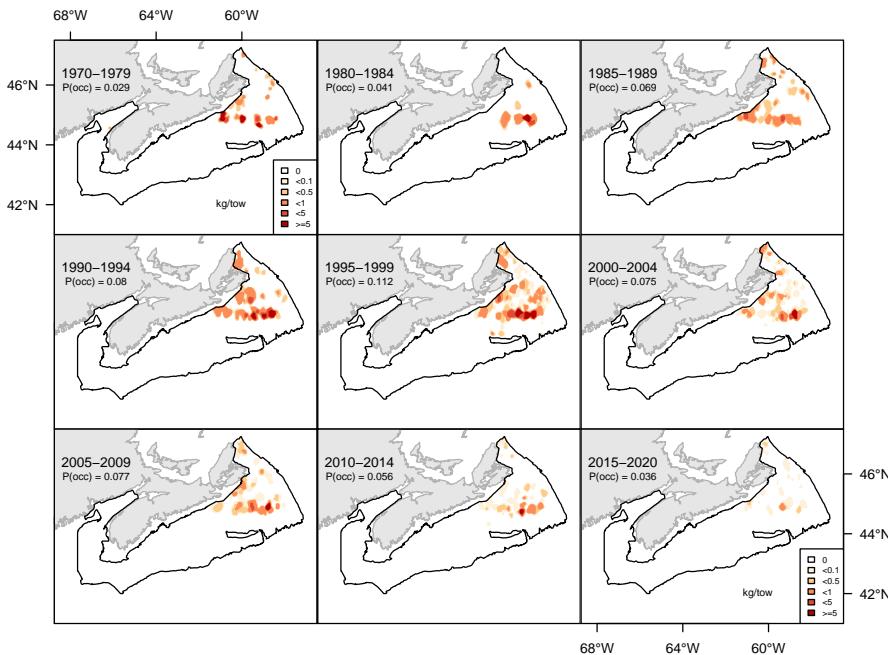


Figure 7.46A. Inverse distance weighted distribution of catch biomass (kg/tow) for Vahl's eelpout.

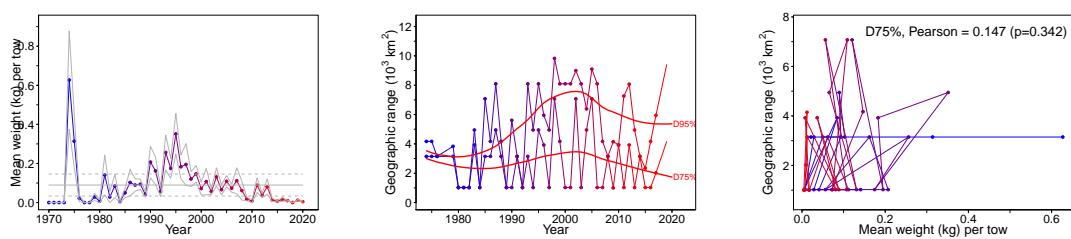


Figure 7.46B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Vahl's eelpout.

7.47 Atlantic butterfish (Stromaté fossette) - species code 701 (category LI)

Scientific name: [Peprilus triacanthus](#)

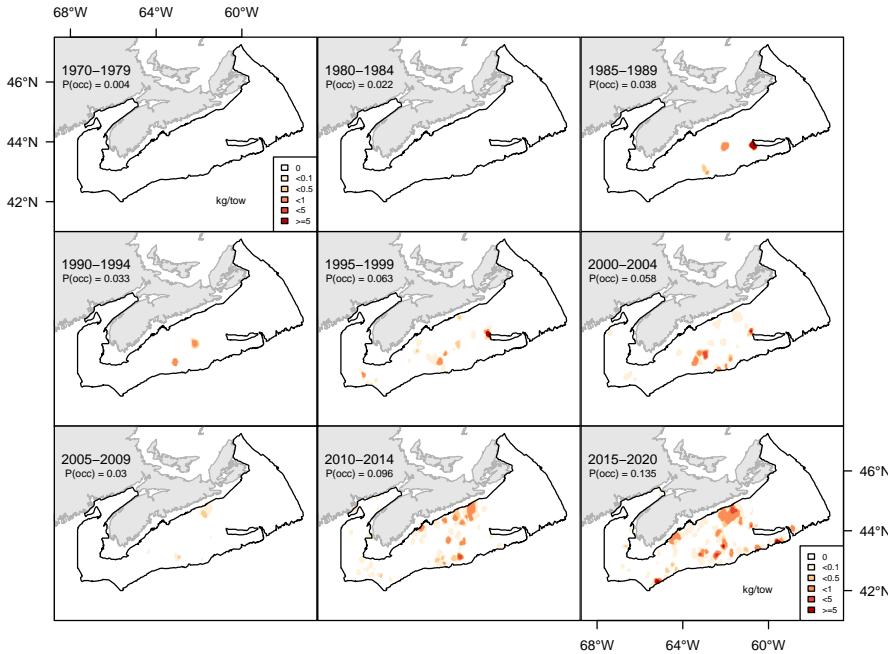


Figure 7.47A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic butterfish.

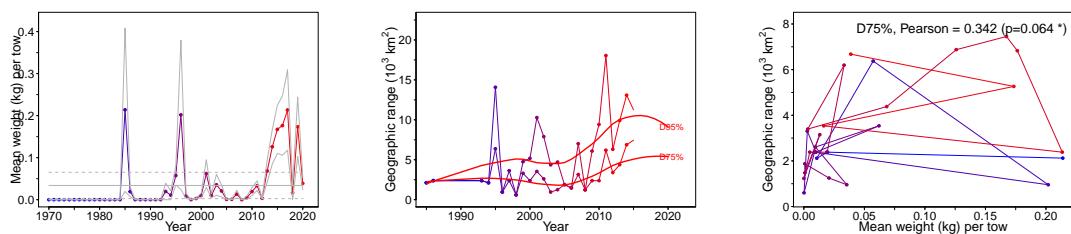


Figure 7.47B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic butterfish.

7.48 Atlantic hookear sculpin (Hameçon atlantique) - species code 880 (category LI)

Scientific name: [Artediellus atlanticus](#)

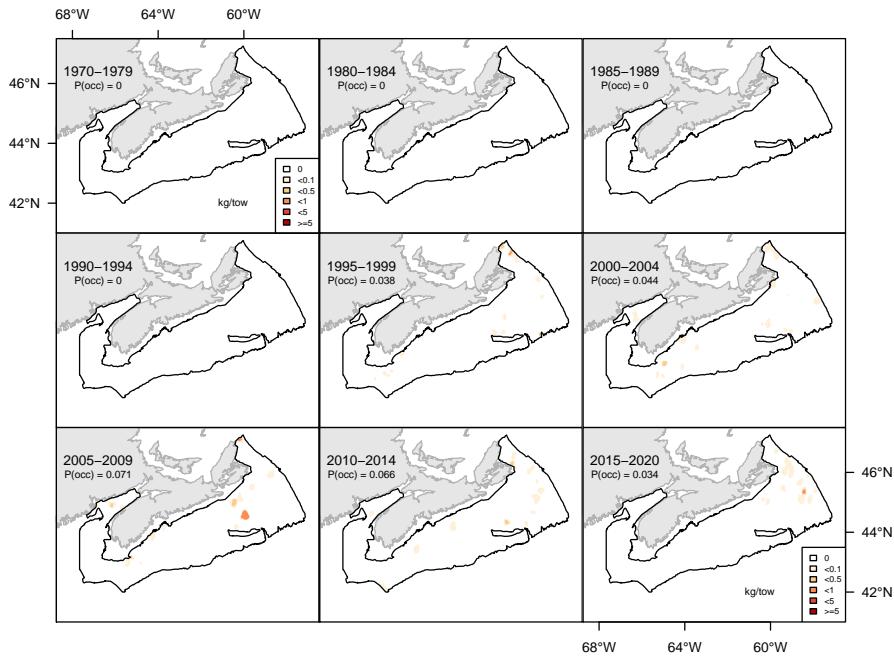


Figure 7.48A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic hookear sculpin.

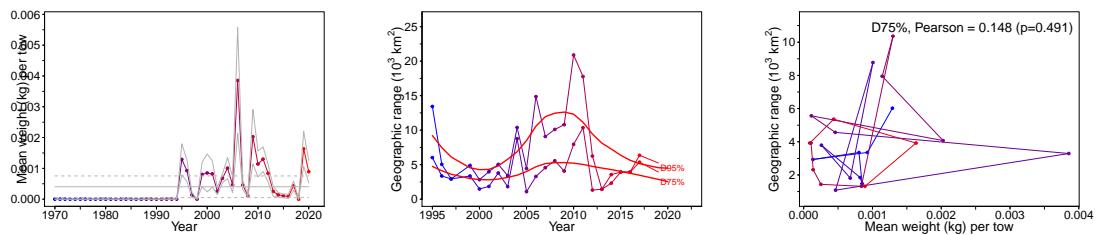


Figure 7.48B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic hookear sculpin.

7.49 Barndoor skate (Grande raie) - species code 200 (category LI)

Scientific name: [Dipturus laevis](#)

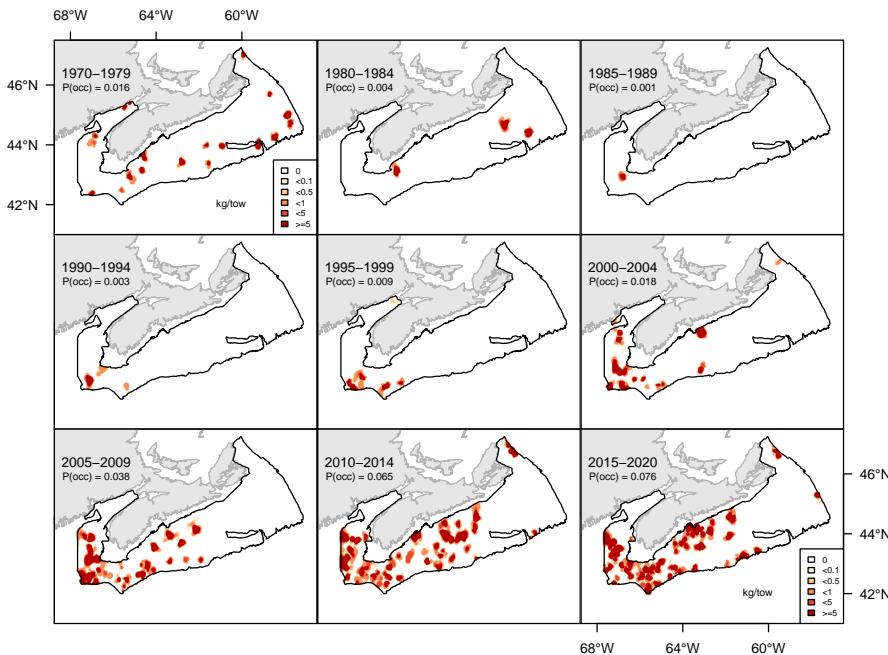


Figure 7.49A. Inverse distance weighted distribution of catch biomass (kg/tow) for Barndoor skate.

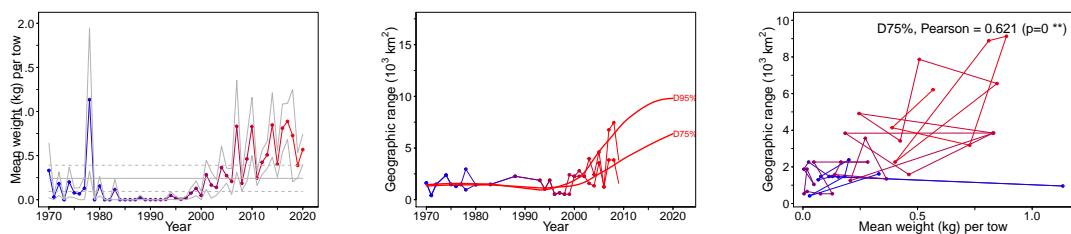


Figure 7.49B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Barndoor skate.

7.50 Little skate (Raie hérisson) - species code 203 (category LI)

Scientific name: [Leucoraja erinacea](#)

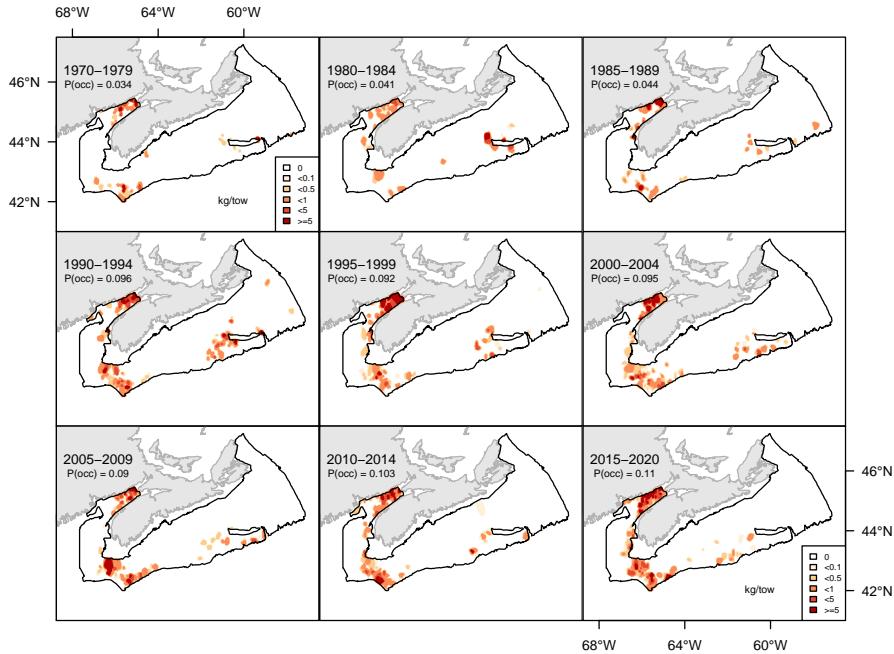


Figure 7.50A. Inverse distance weighted distribution of catch biomass (kg/tow) for Little skate.

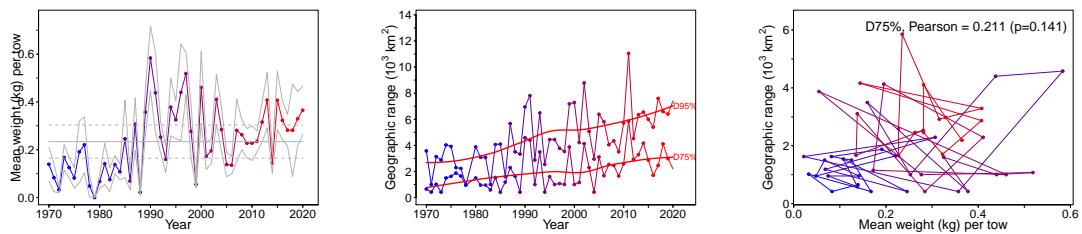


Figure 7.50B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Little skate.

7.51 Northern prawn (Crevette nordique) - species code 2211 (category SF)

Scientific name: [Pandalus borealis](#)

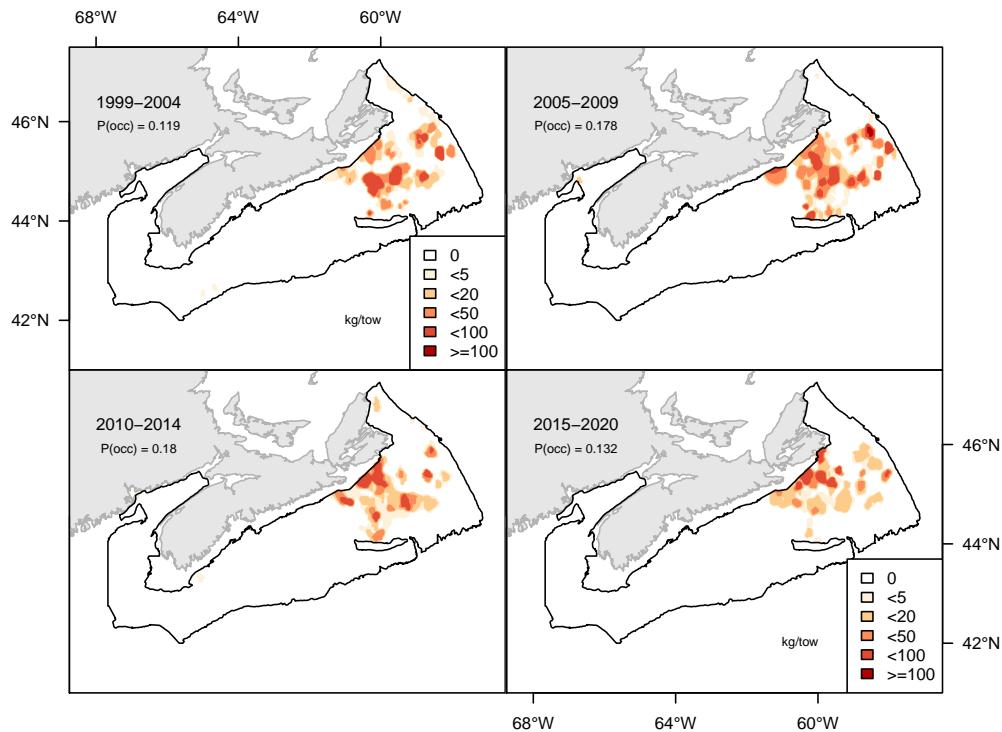


Figure 7.51A. Inverse distance weighted distribution of catch biomass (kg/tow) for Northern prawn.

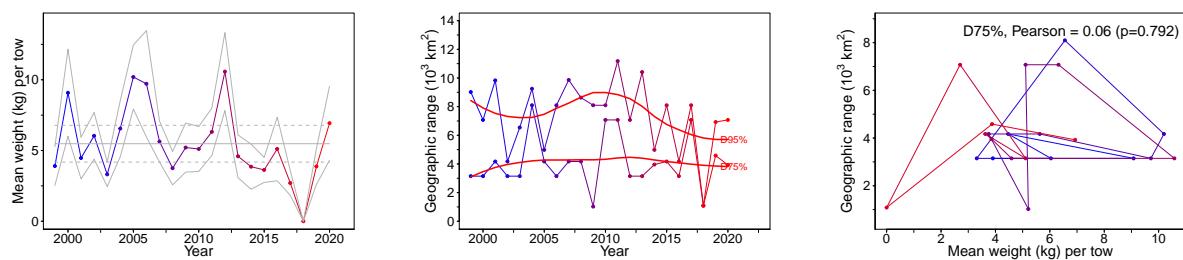


Figure 7.51B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Northern prawn.

7.52 Jonah crab (Tourteau jona) - species code 2511 (category SF)

Scientific name: [Cancer borealis](#)

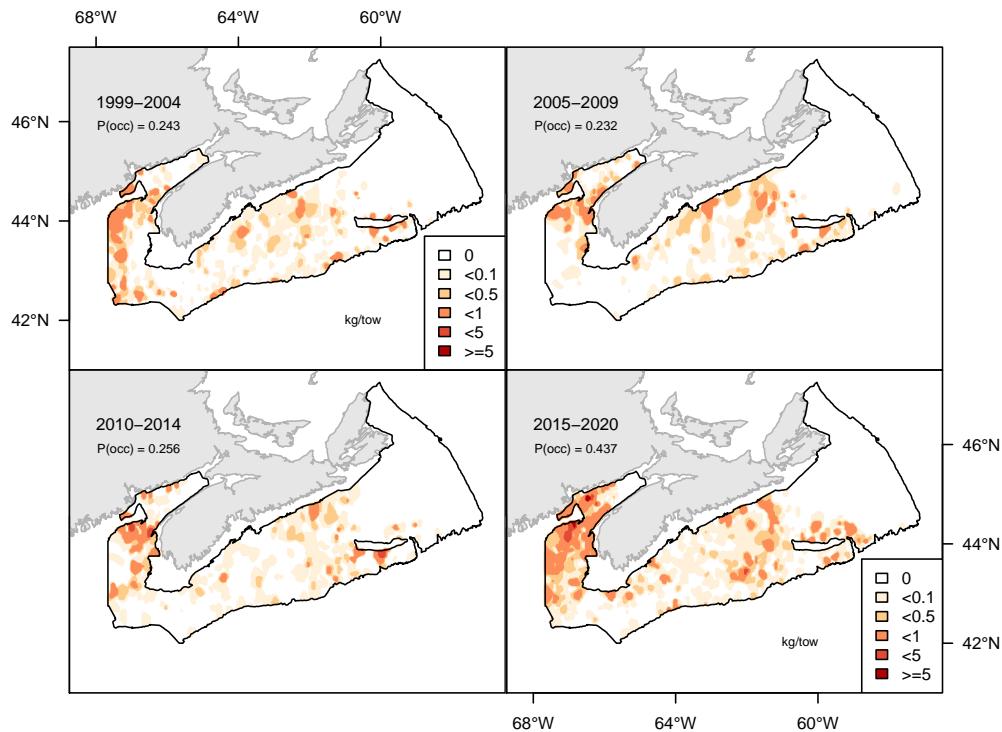


Figure 7.52A. Inverse distance weighted distribution of catch biomass (kg/tow) for Jonah crab.

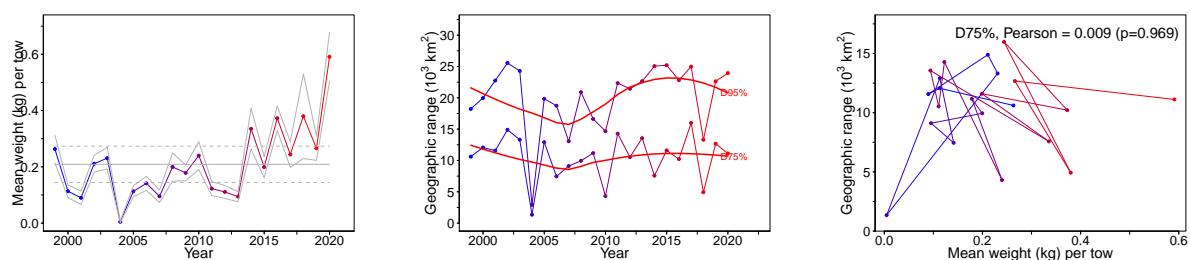


Figure 7.52B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Jonah crab.

7.53 Atlantic rock crab (Tourteau poïnclos) - species code 2513 (category SF)

Scientific name: [Cancer irroratus](#)

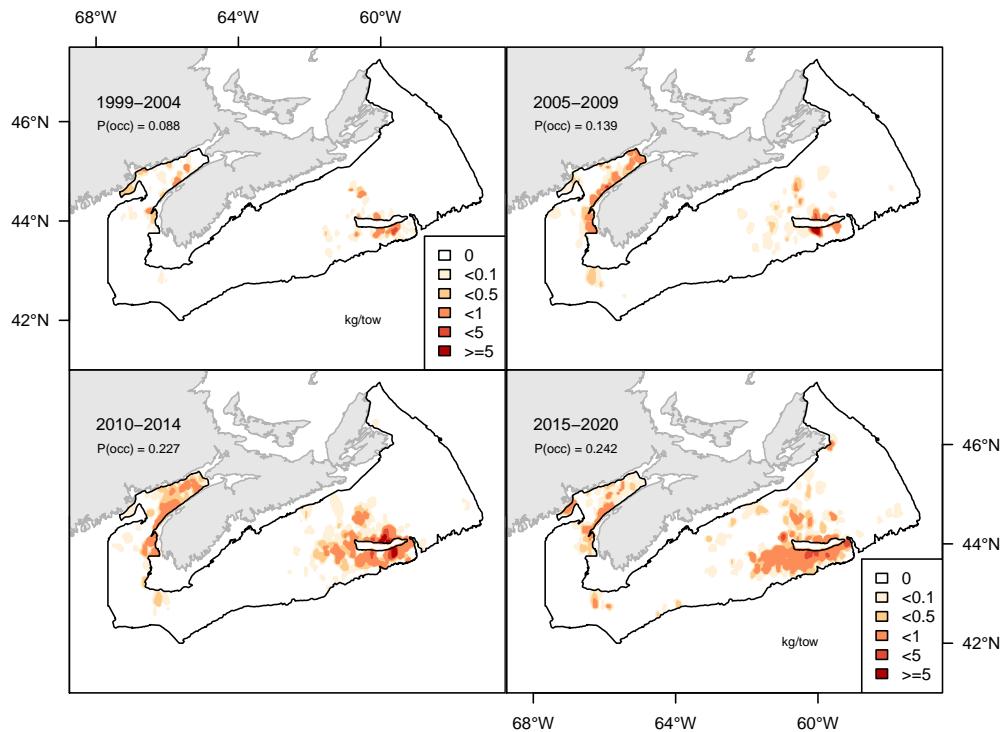


Figure 7.53A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic rock crab.

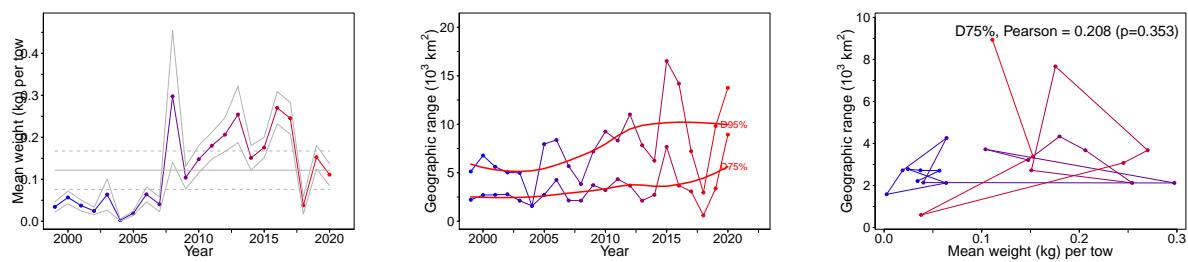


Figure 7.53B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic rock crab.

7.54 Arctic lyre crab (*Crabe Hyas coarctatus*) - species code 2521 (category SF)

Scientific name: [Hyas coarctatus](#)

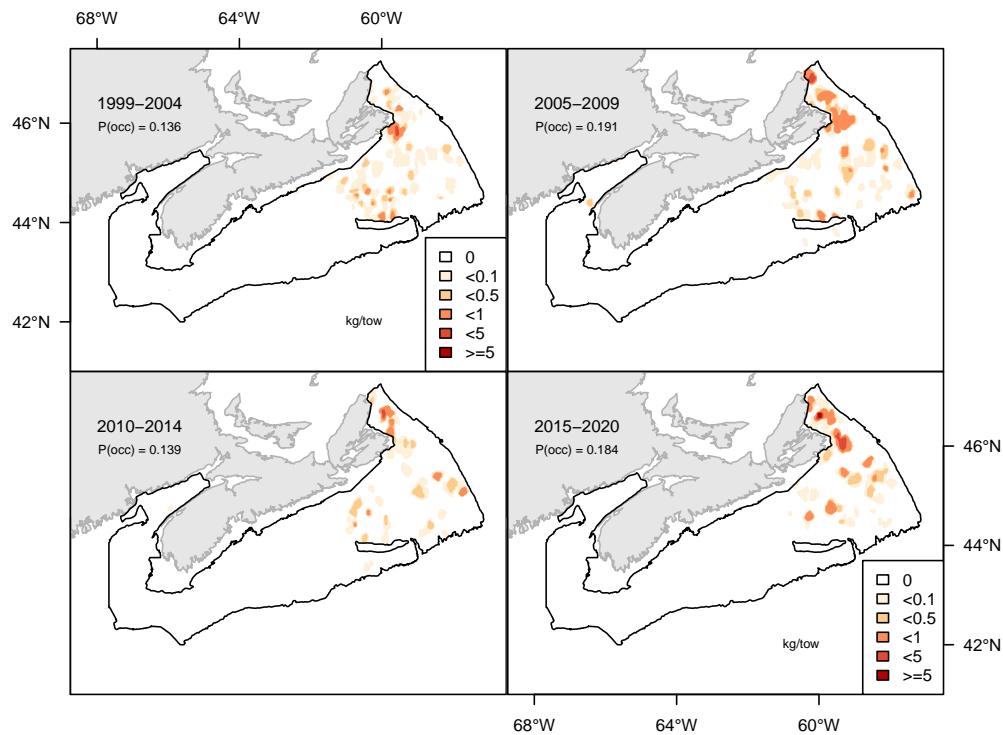


Figure 7.54A. Inverse distance weighted distribution of catch biomass (kg/tow) for Arctic lyre crab.

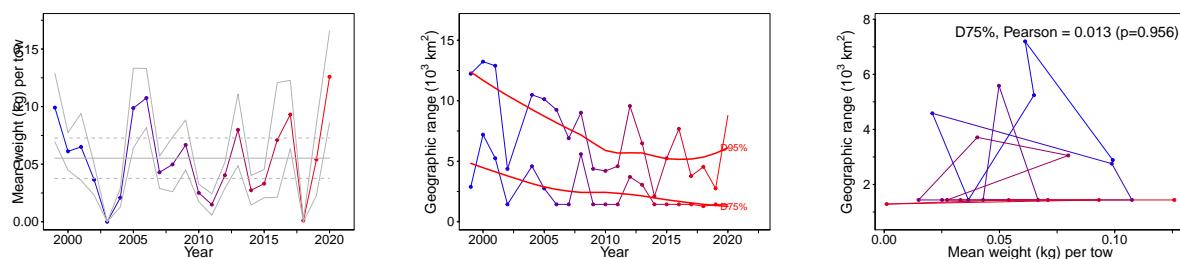


Figure 7.54B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Arctic lyre crab.

7.55 Atlantic king crab (Crabe épineux du nord) - species code 2523 (category SF)

Scientific name: [Lithodes maja](#)

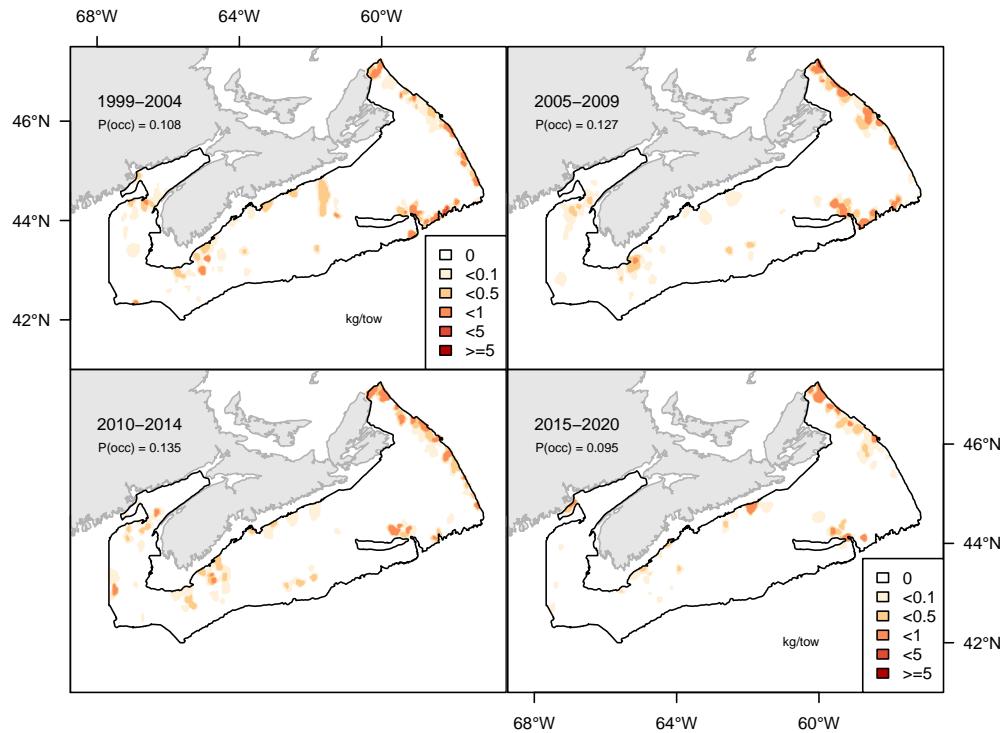


Figure 7.55A. Inverse distance weighted distribution of catch biomass (kg/tow) for Atlantic king crab.

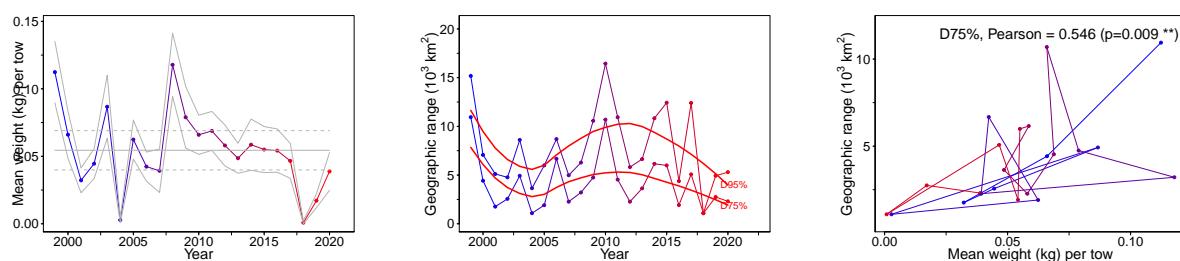


Figure 7.55B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Atlantic king crab.

7.56 Queen crab (Crabe des neiges) - species code 2526 (category SF)

Scientific name: [Chionoecetes opilio](#)

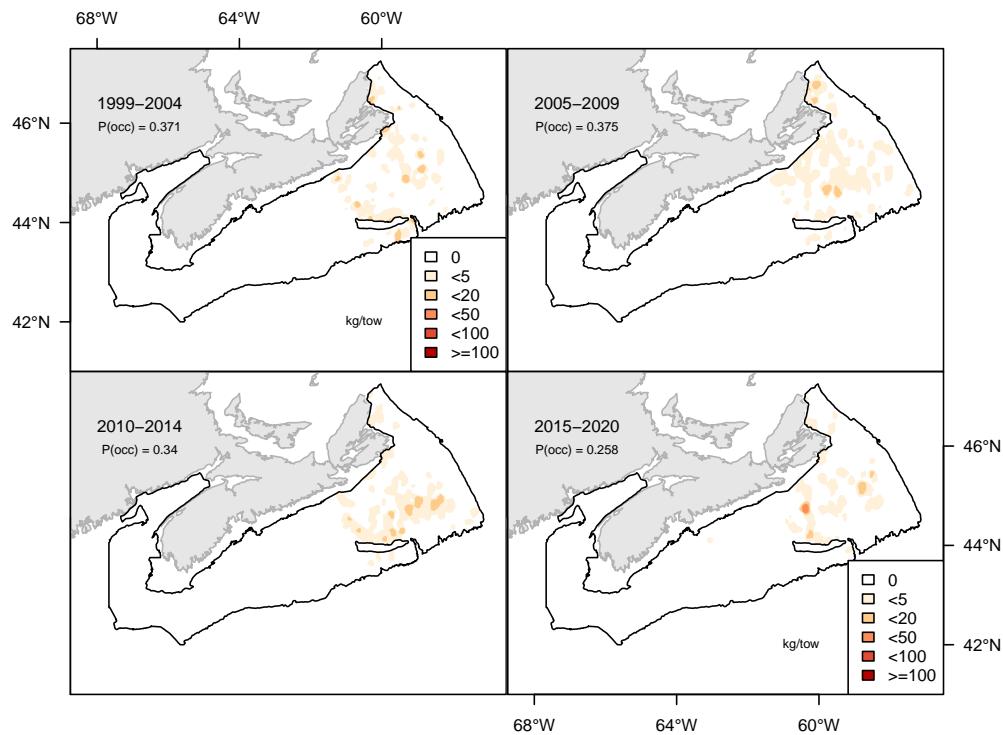


Figure 7.56A. Inverse distance weighted distribution of catch biomass (kg/tow) for Queen crab.

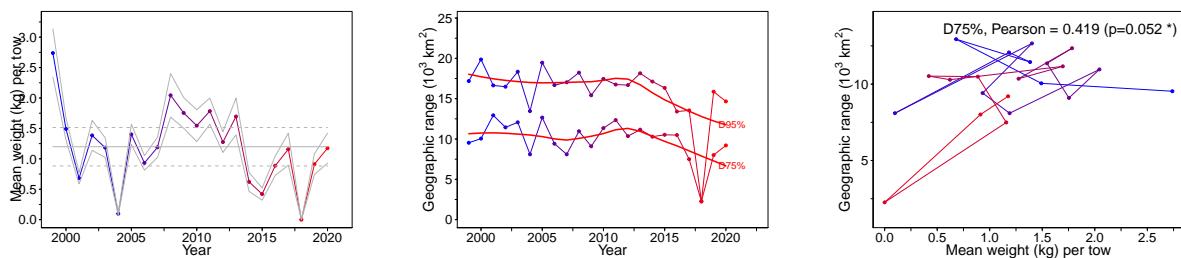


Figure 7.56B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Queen crab.

7.57 Great spider crab (Crabe lyre araignée) - species code 2527 (category SF)

Scientific name: [Hyas araneus](#)

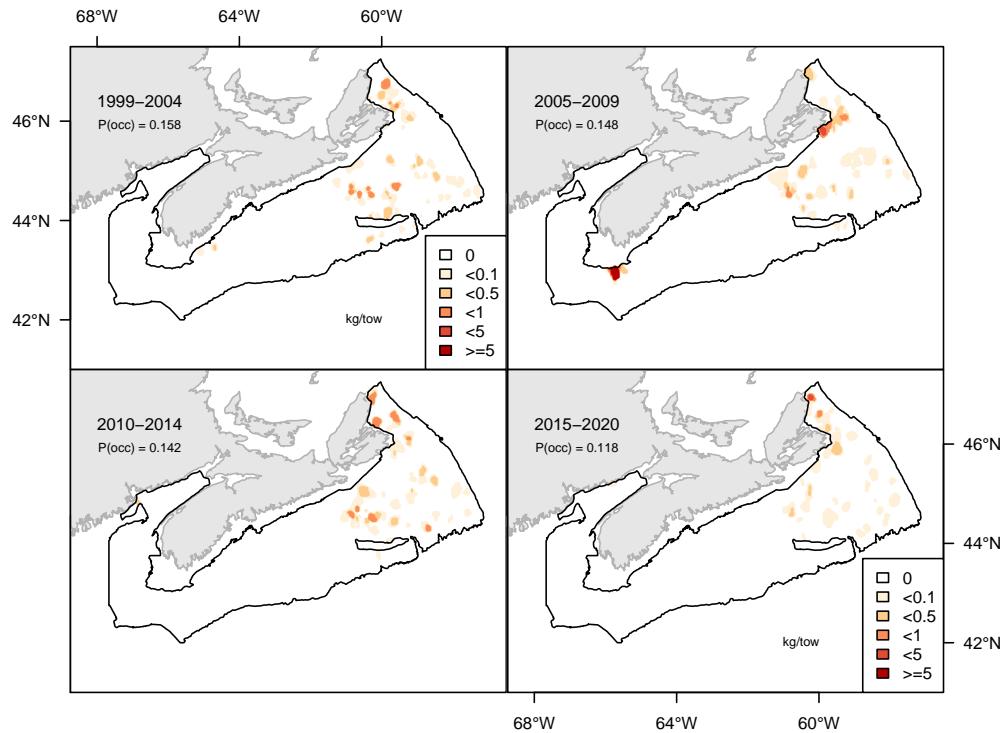


Figure 7.57A. Inverse distance weighted distribution of catch biomass (kg/tow) for Great spider crab.

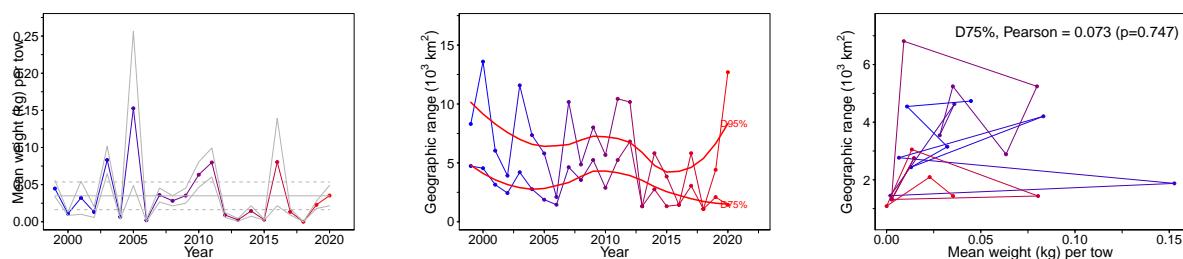


Figure 7.57B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of Great spider crab.

7.58 American lobster (Homard américain) - species code 2550 (category SF)

Scientific name: [Homarus americanus](#)

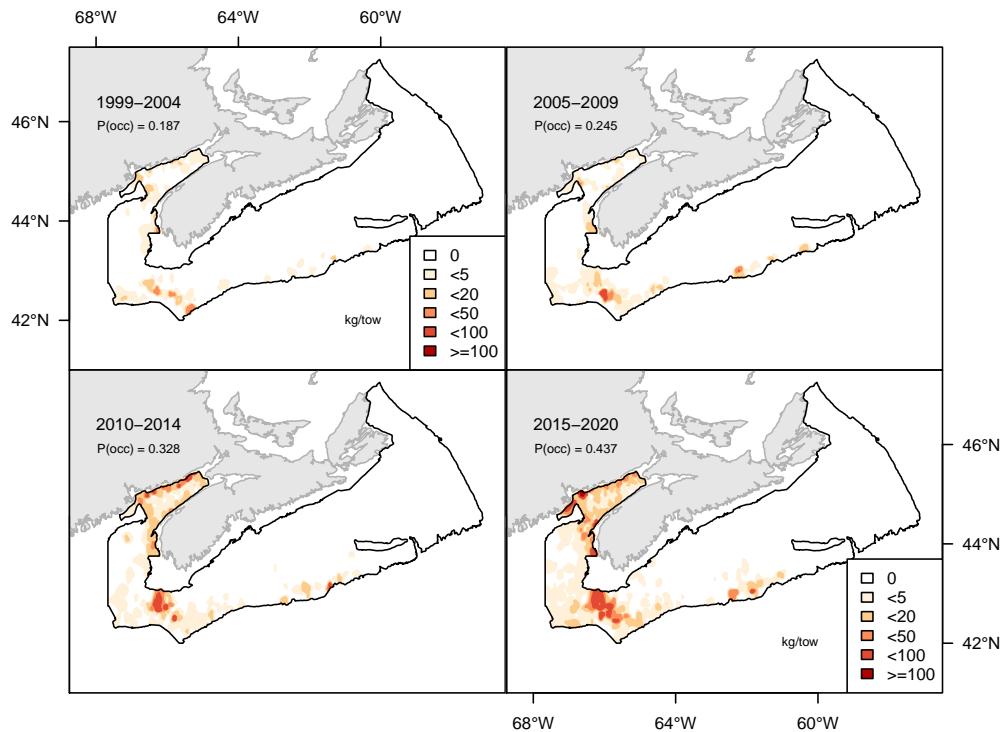


Figure 7.58A. Inverse distance weighted distribution of catch biomass (kg/tow) for American lobster.

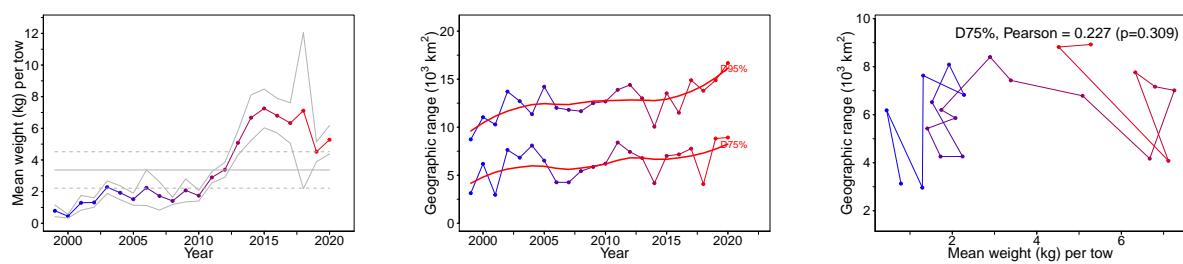


Figure 7.58B. Stratified random estimates of biomass (kg/tow), D75 and D95 and the correlation between D75 and biomass of American lobster.

7.59 Sea lamprey (*Lamproie marine*) - species code 240 (category LR)

Scientific name: [Petromyzon marinus](#)

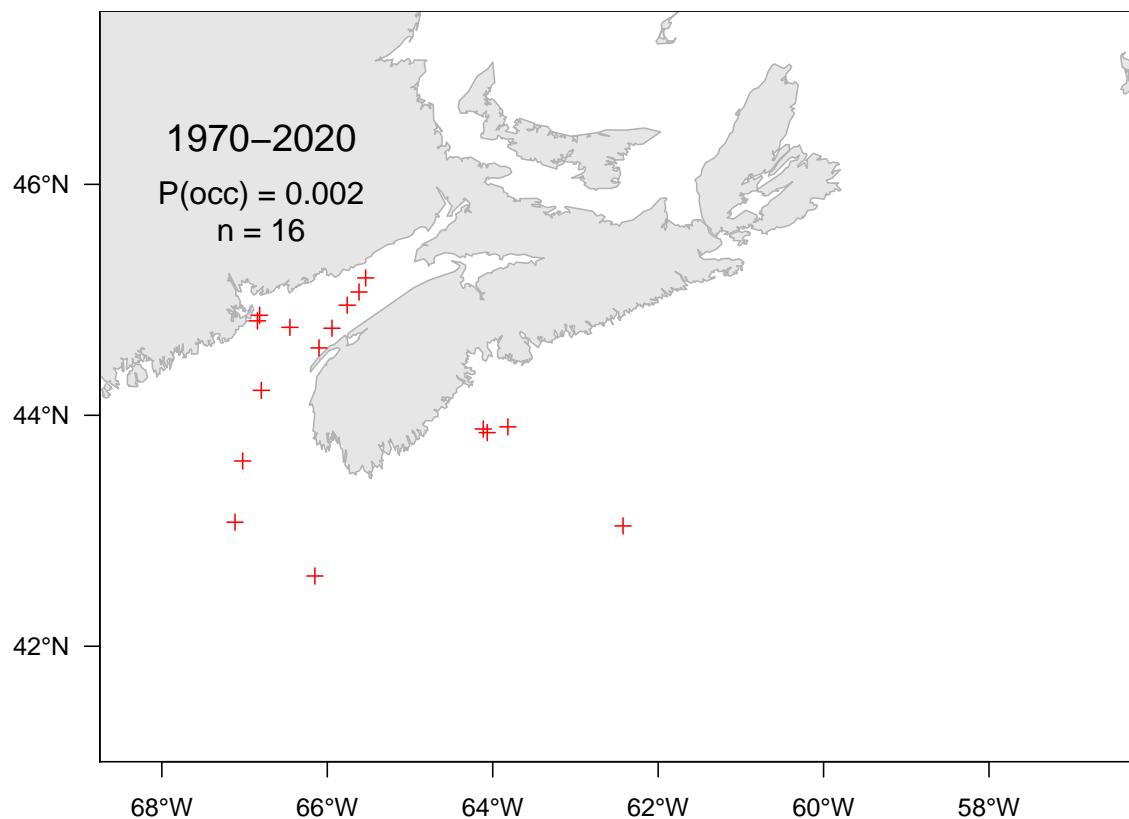


Figure 7.59A. Catch distribution for Sea lamprey.

7.60 Atlantic tomcod (*Poulamon atlantique*) - species code 17 (category LR)

Scientific name: [Micogadus tomcod](#)

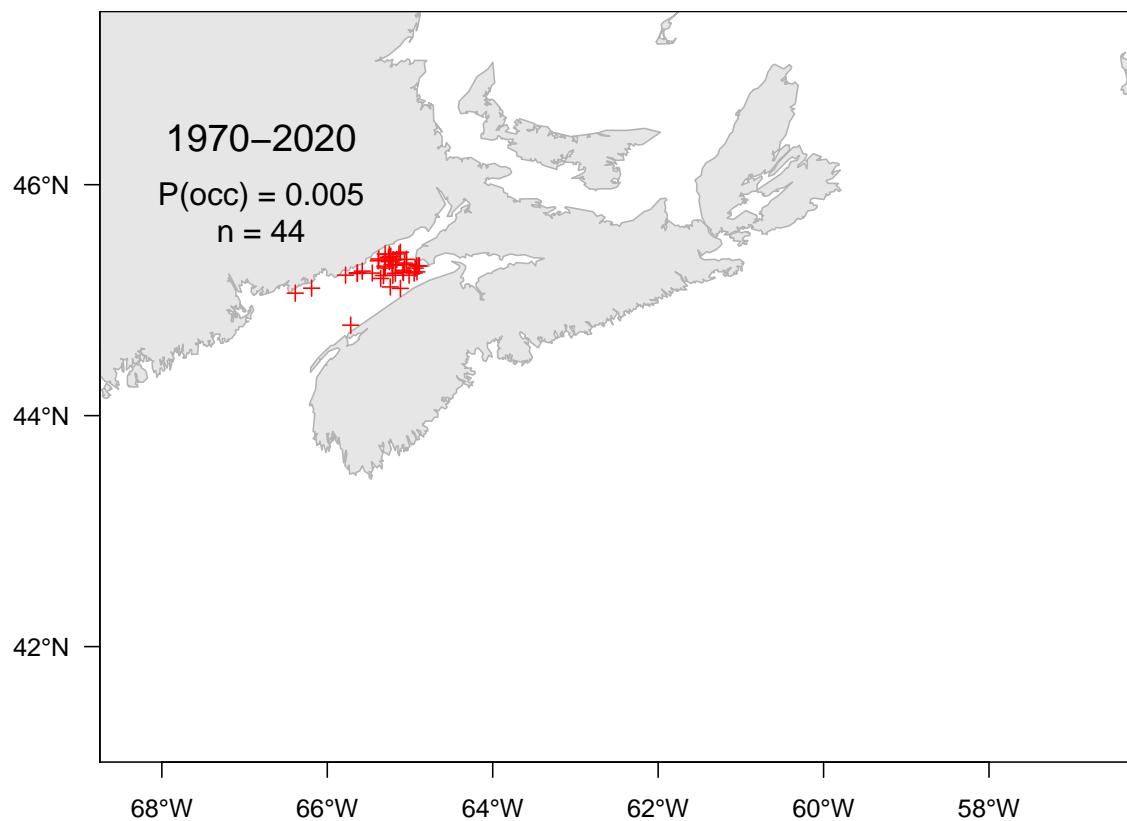


Figure 7.60A. Catch distribution for Atlantic tomcod.

7.61 Offshore silver hake (Merlu argenté du large) - species code 19 (category LR)

Scientific name: [Merluccius albidus](#)

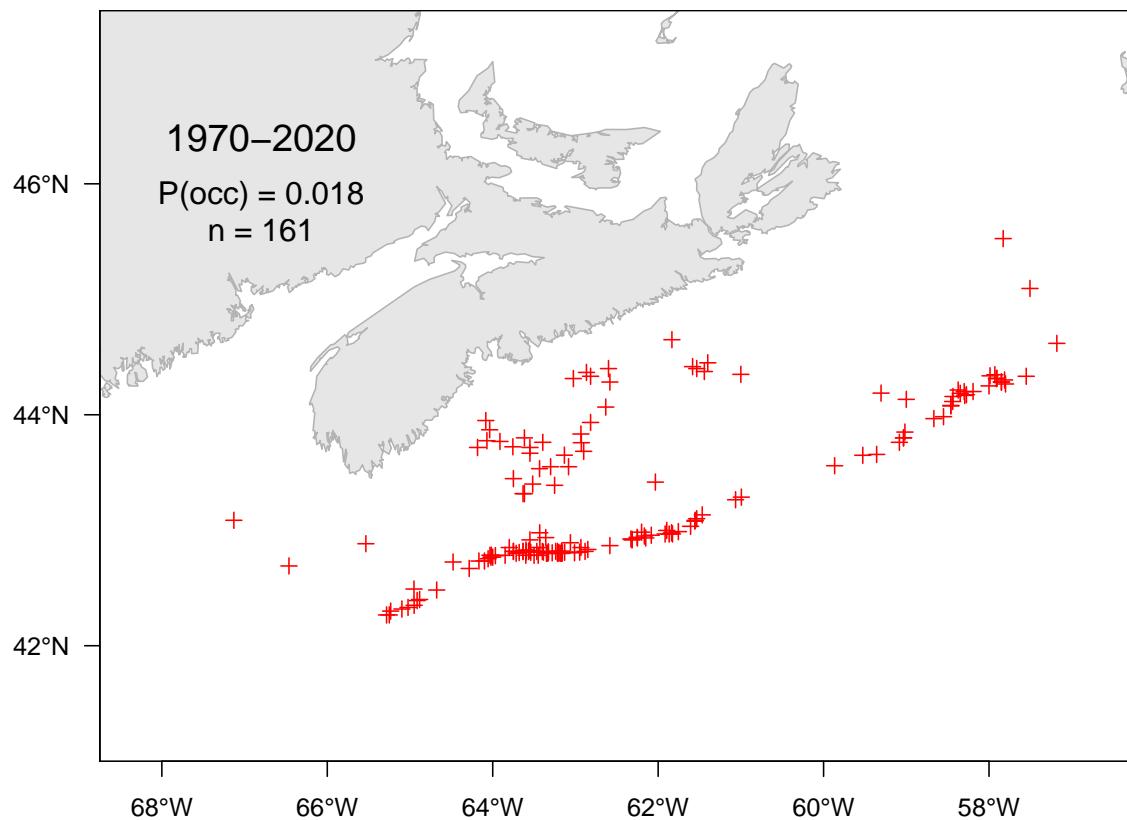


Figure 7.61A. Catch distribution for Offshore silver hake.

7.62 Spotted wolffish (Loup tacheté) - species code 51 (category LR)

Scientific name: [Anarhichas minor](#)

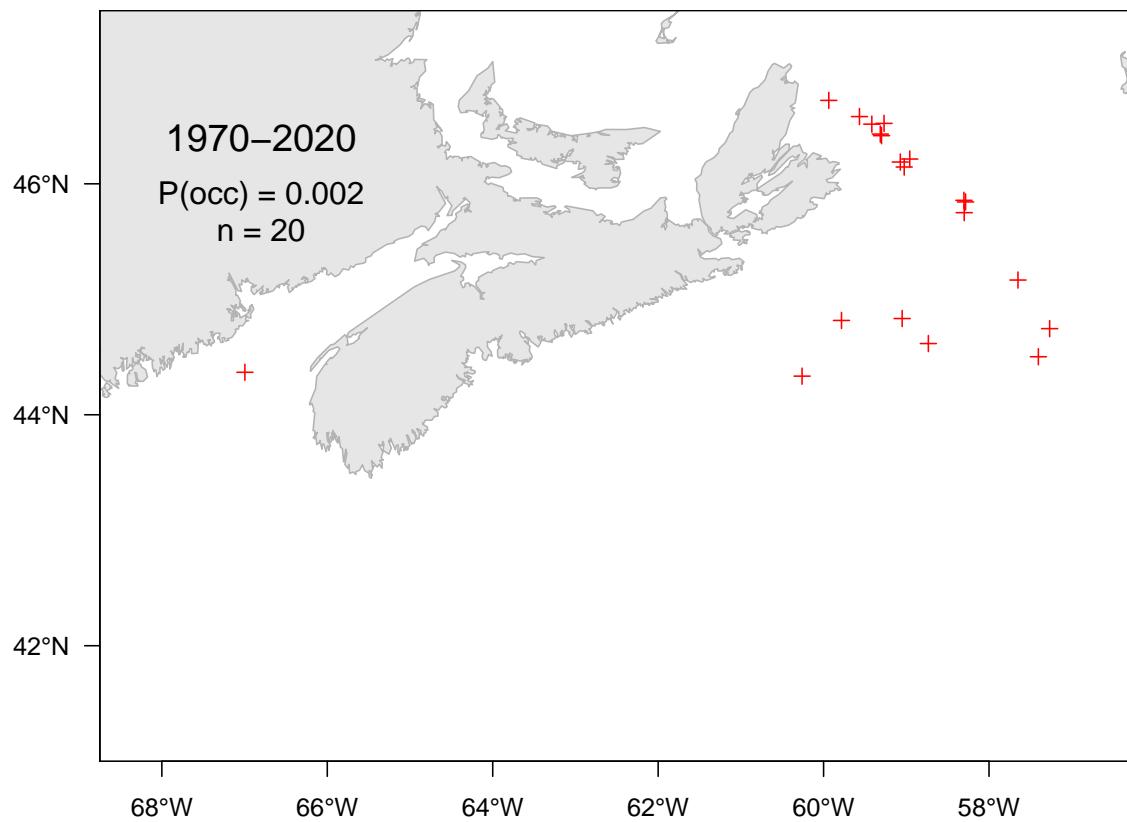


Figure 7.62A. Catch distribution for Spotted wolffish.

7.63 Northern wolffish (Loup à tête large) - species code 52 (category LR)

Scientific name: [Anarhichas denticulatus](#)

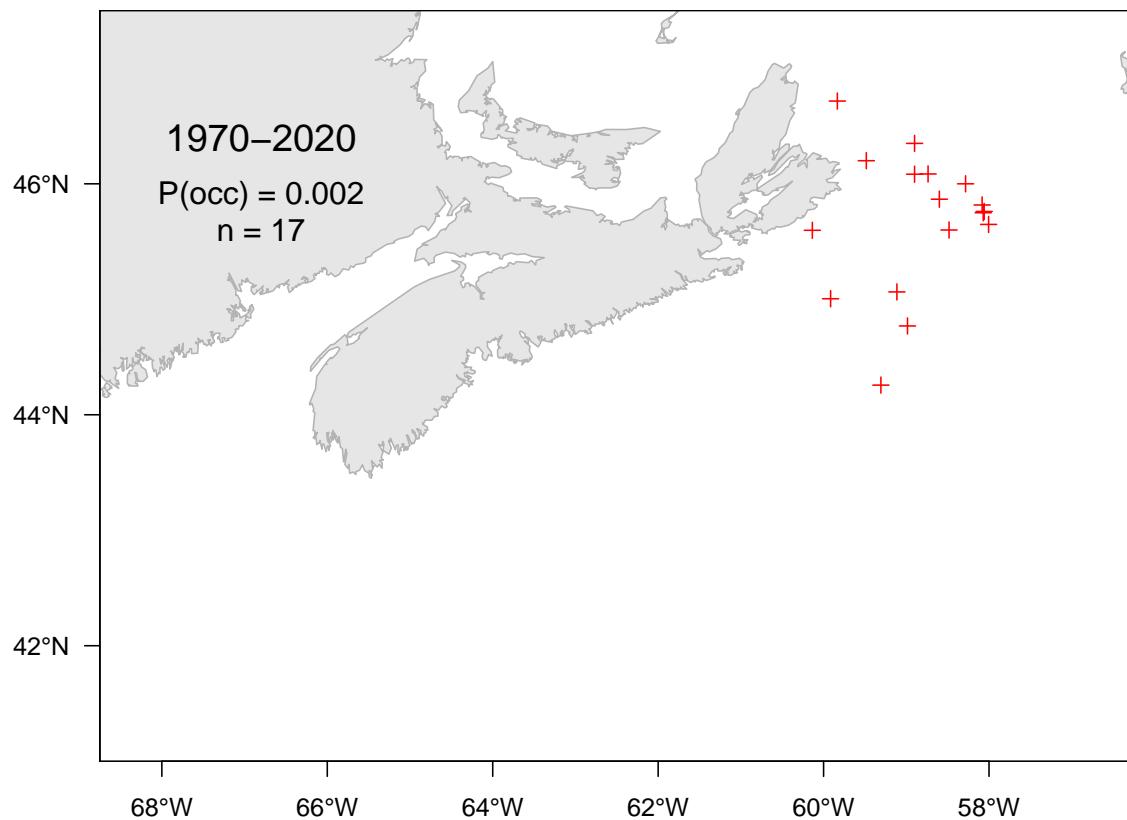


Figure 7.63A. Catch distribution for Northern wolffish.

7.64 Rainbow smelt (Éperlan arc-en-ciel) - species code 63 (category LR)

Scientific name: [Osmerus mordax](#)

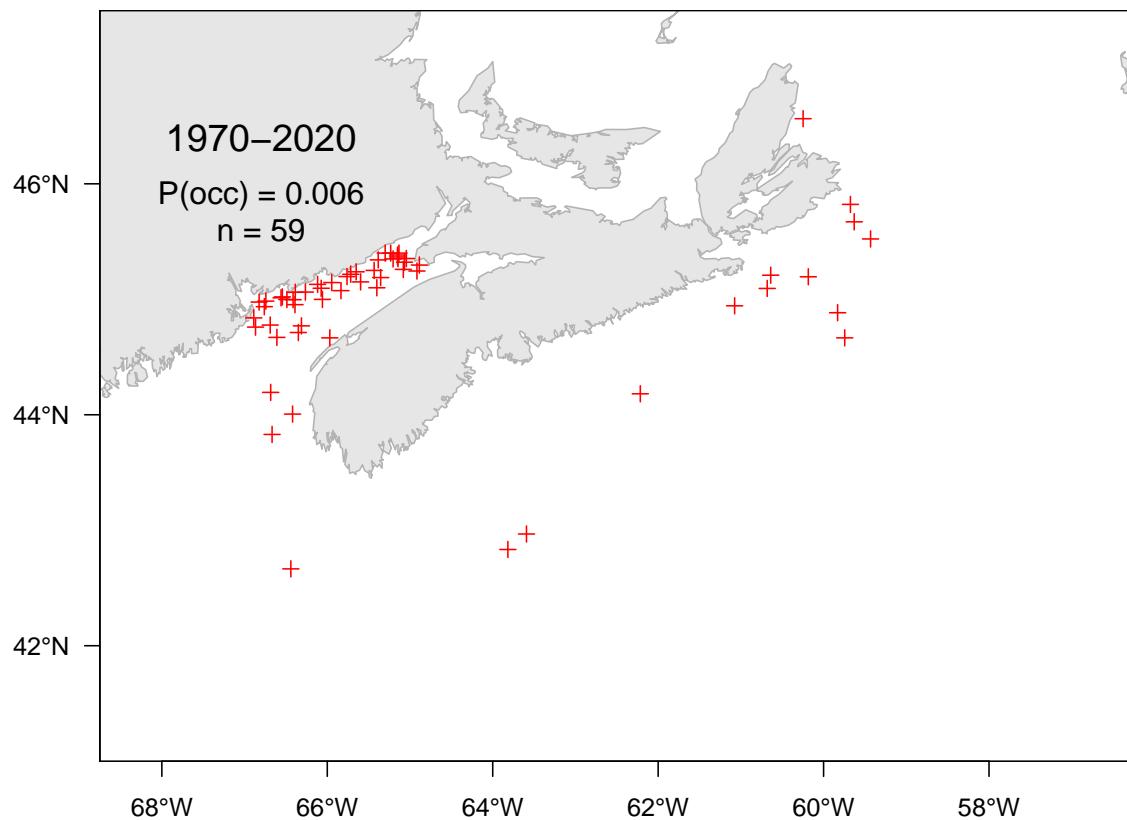


Figure 7.64A. Catch distribution for Rainbow smelt.

7.65 Cunner (Tanche-tautogue) - species code 122 (category LR)

Scientific name: [Tautogolabrus adspersus](#)

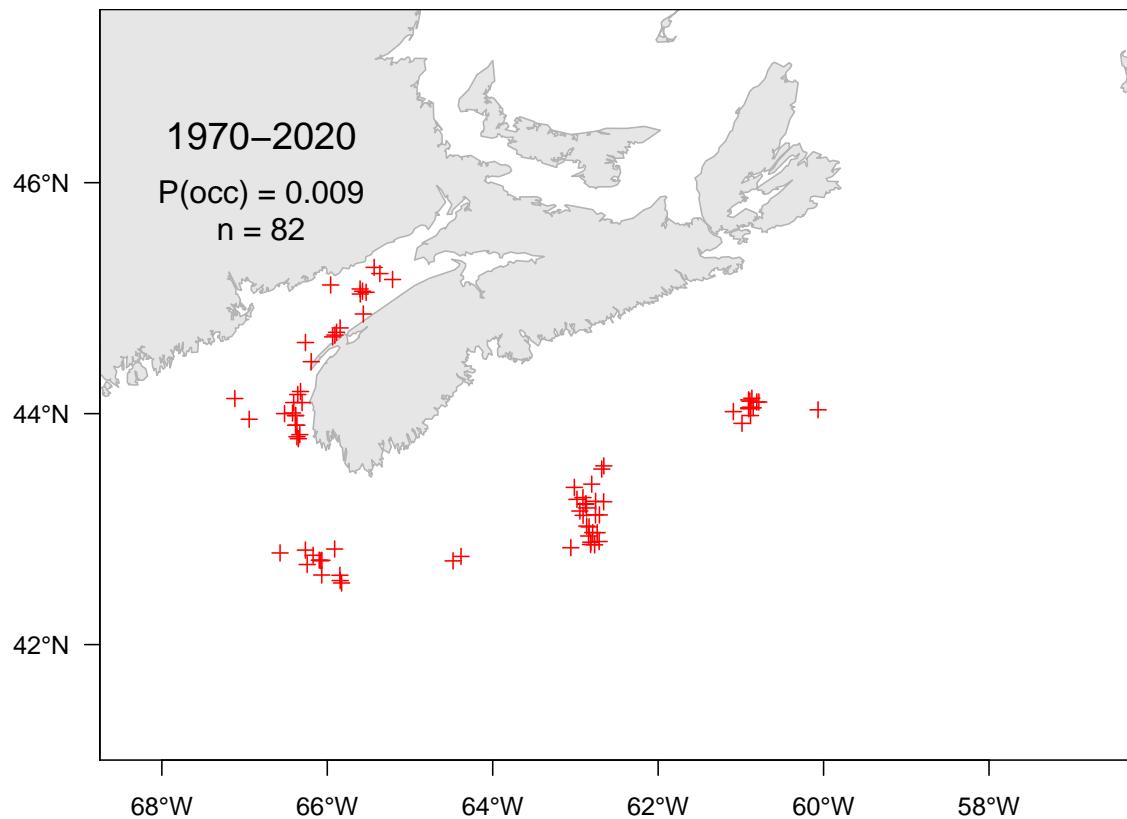


Figure 7.65A. Catch distribution for Cunner.

7.66 Fourspot flounder (Cardeau à quatre ocelles) - species code 142 (category LR)

Scientific name: [Hippoglossina oblonga](#)

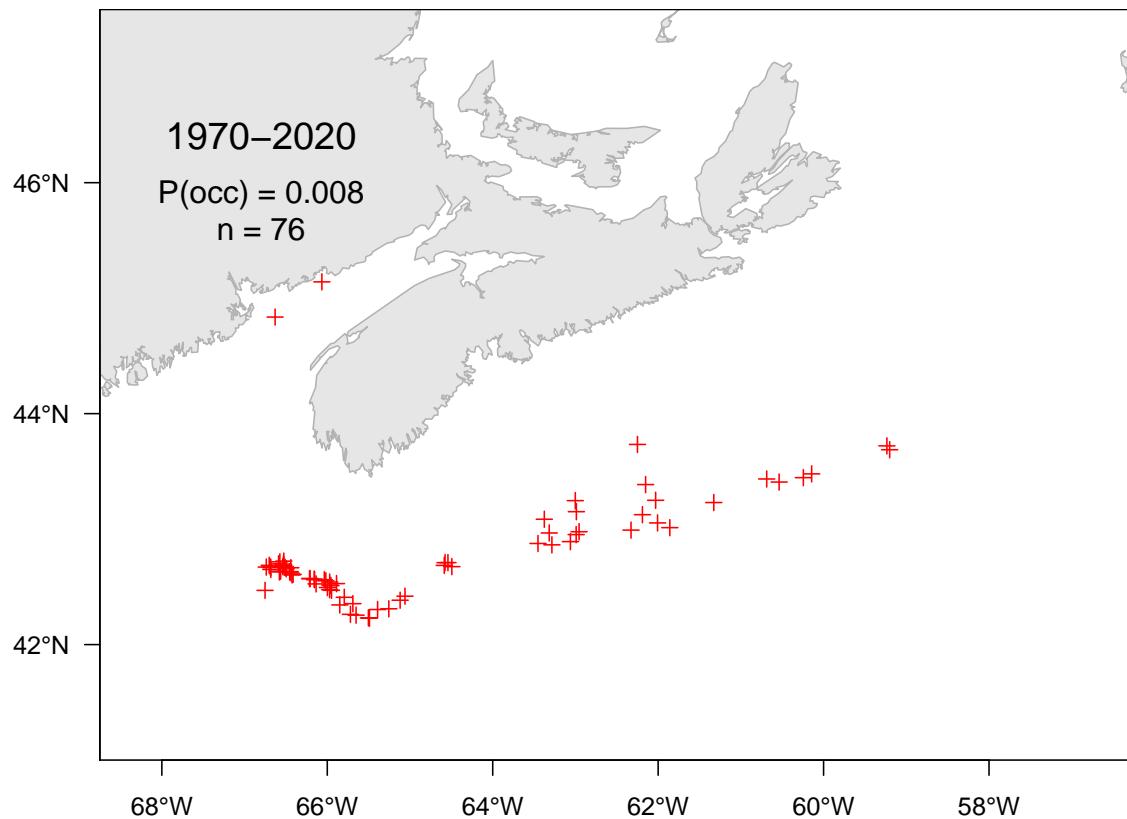


Figure 7.66A. Catch distribution for Fourspot flounder.

7.67 Windowpane flounder (Turbot de sable) - species code 143 (category LR)

Scientific name: [Scophthalmus aquosus](#)

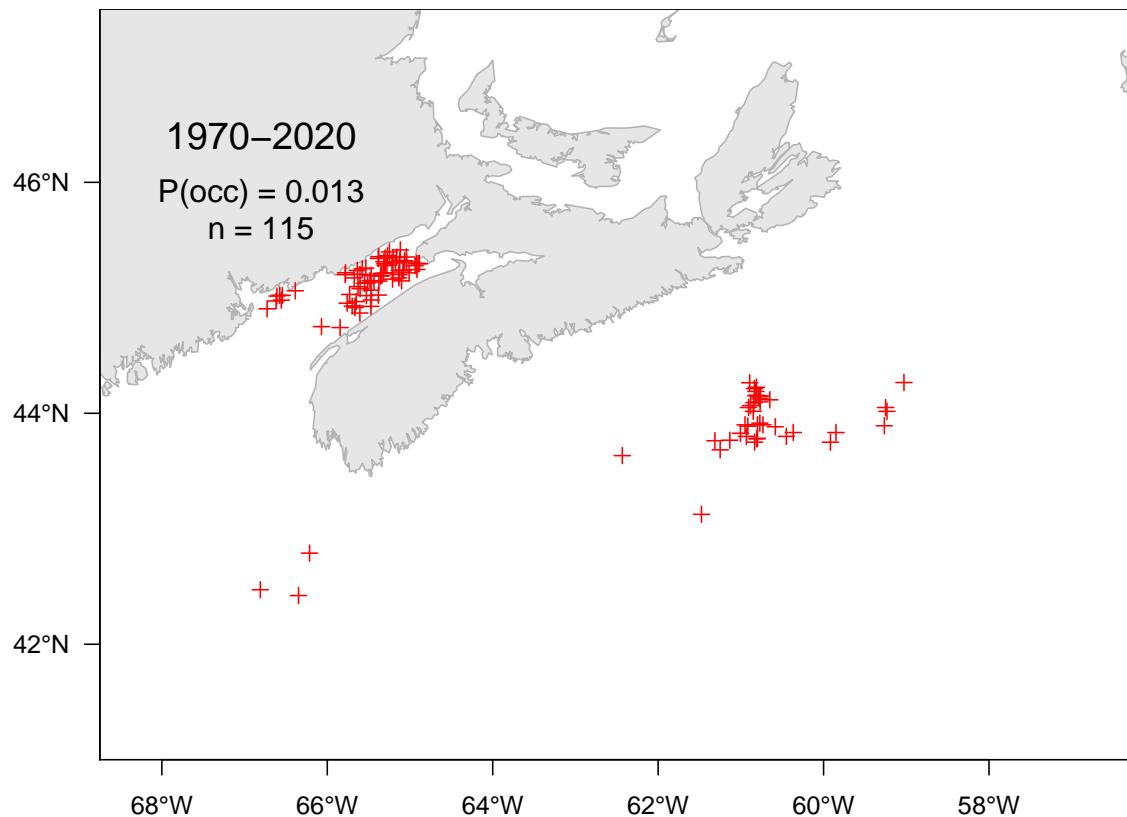


Figure 7.67A. Catch distribution for Windowpane flounder.

7.68 Longnose greeneye (Oeil-vert à long nez) - species code 149 (category LR)

Scientific name: [Parasudis triculenta](#)

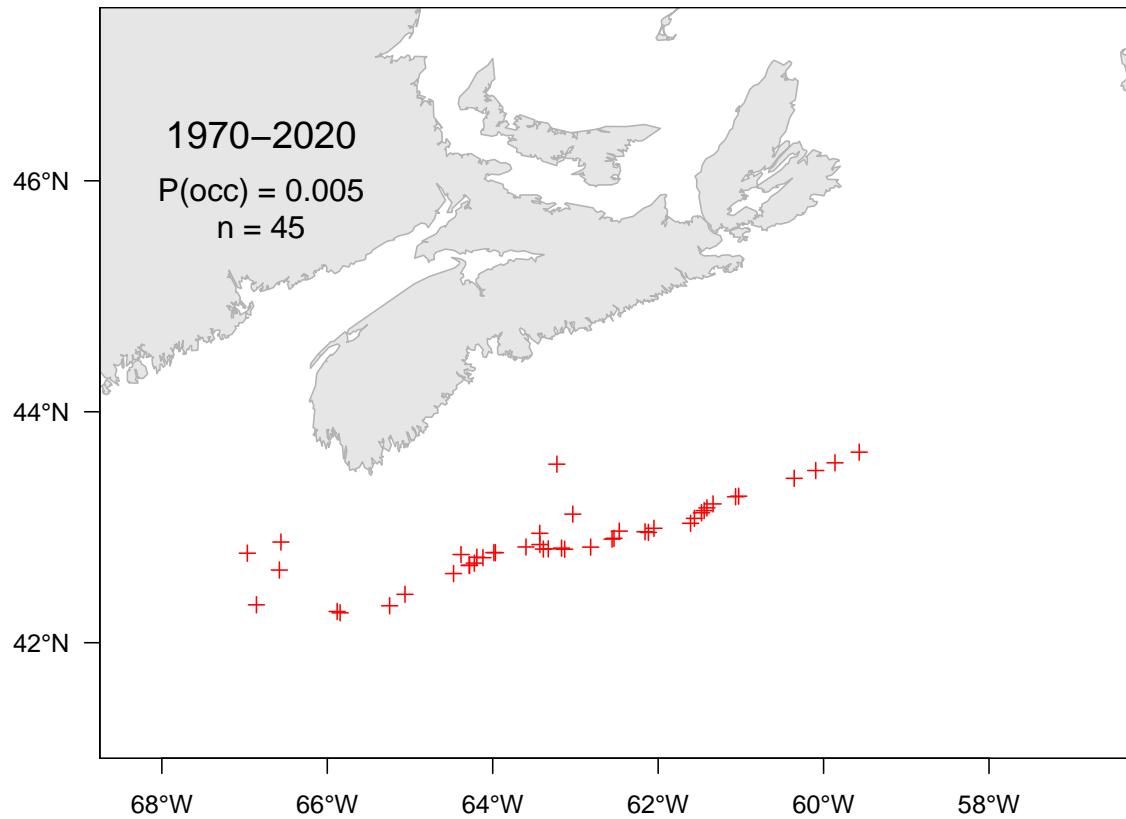


Figure 7.68A. Catch distribution for Longnose greeneye.

7.69 Lanternfishes (Poissons-lanternes) - species code 150 (category LR)

Scientific name: [Myctophidae](#)

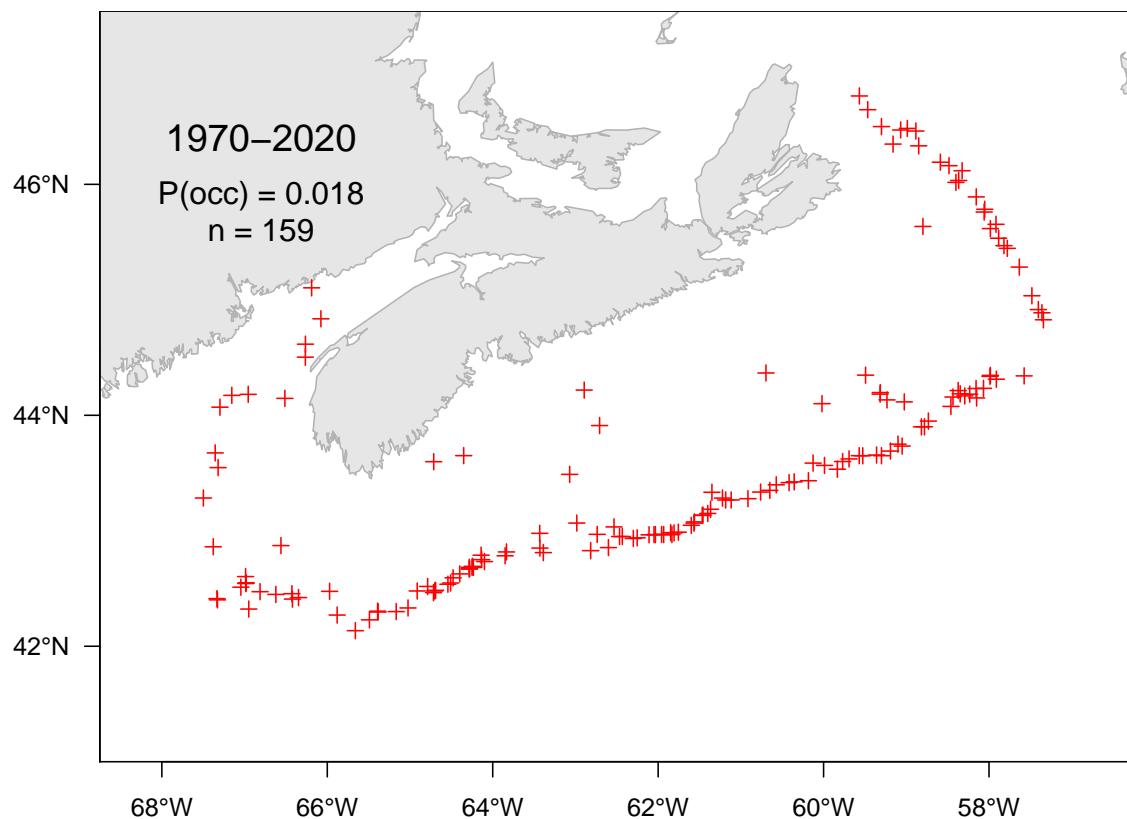


Figure 7.69A. Catch distribution for Lanternfishes.

7.70 Shortnose greeneye (Éperlan du large) - species code 156 (category LR)

Scientific name: [Chlorophthalmus agassizi](#)

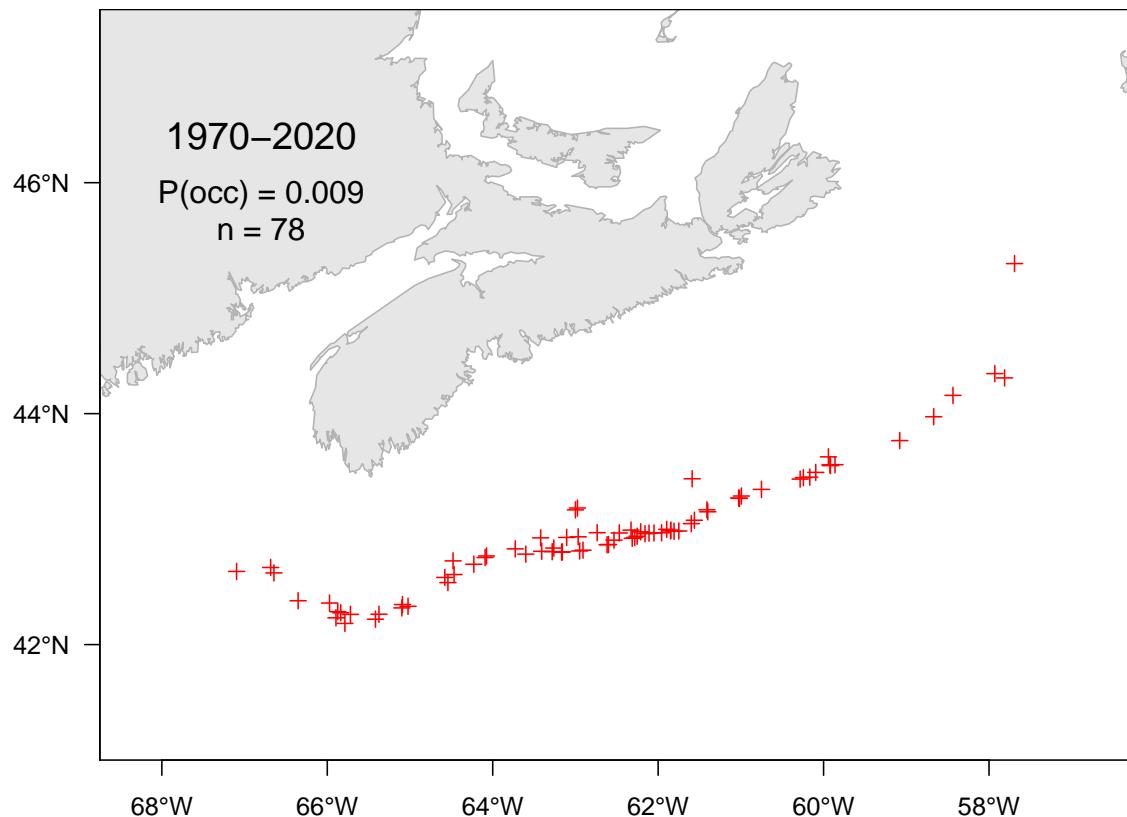


Figure 7.70A. Catch distribution for Shortnose greeneye.

7.71 Silvery lightfish (Brossé améthyste) - species code 158 (category LR)

Scientific name: [Maurolicus muelleri](#)

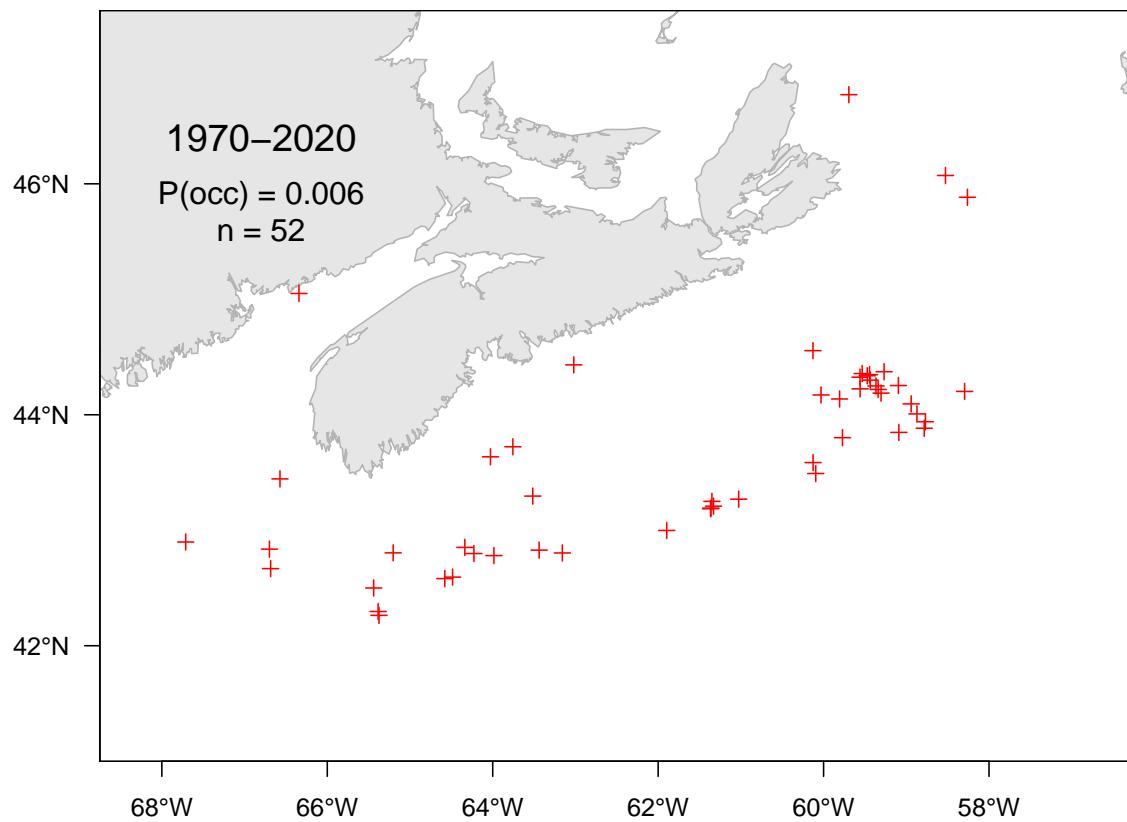


Figure 7.71A. Catch distribution for Silvery lightfish.

7.72 Boa dragonfish (Dragon-boa) - species code 159 (category LR)

Scientific name: [Stomias boa](#)

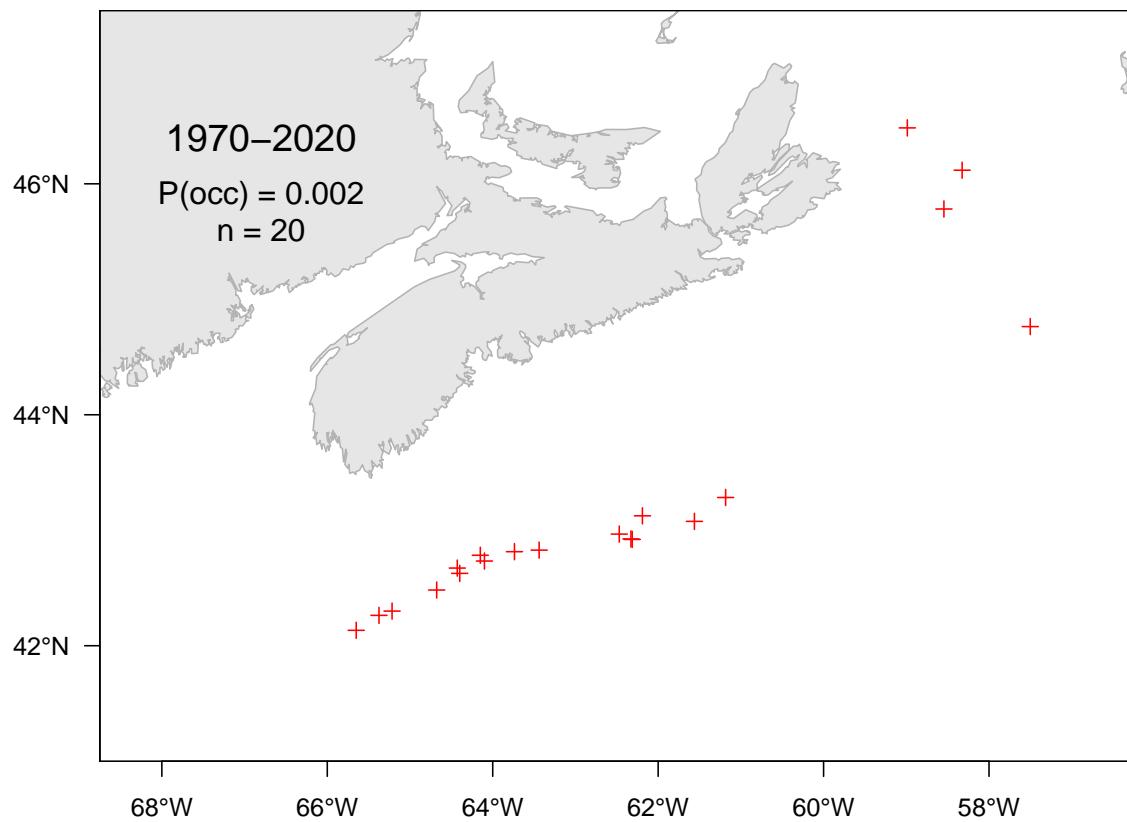


Figure 7.72A. Catch distribution for Boa dragonfish.

7.73 Shorthorn sculpin (Chabosseau à épines courtes) - species code 301 (category LR)

Scientific name: [Myoxocephalus scorpius](#)

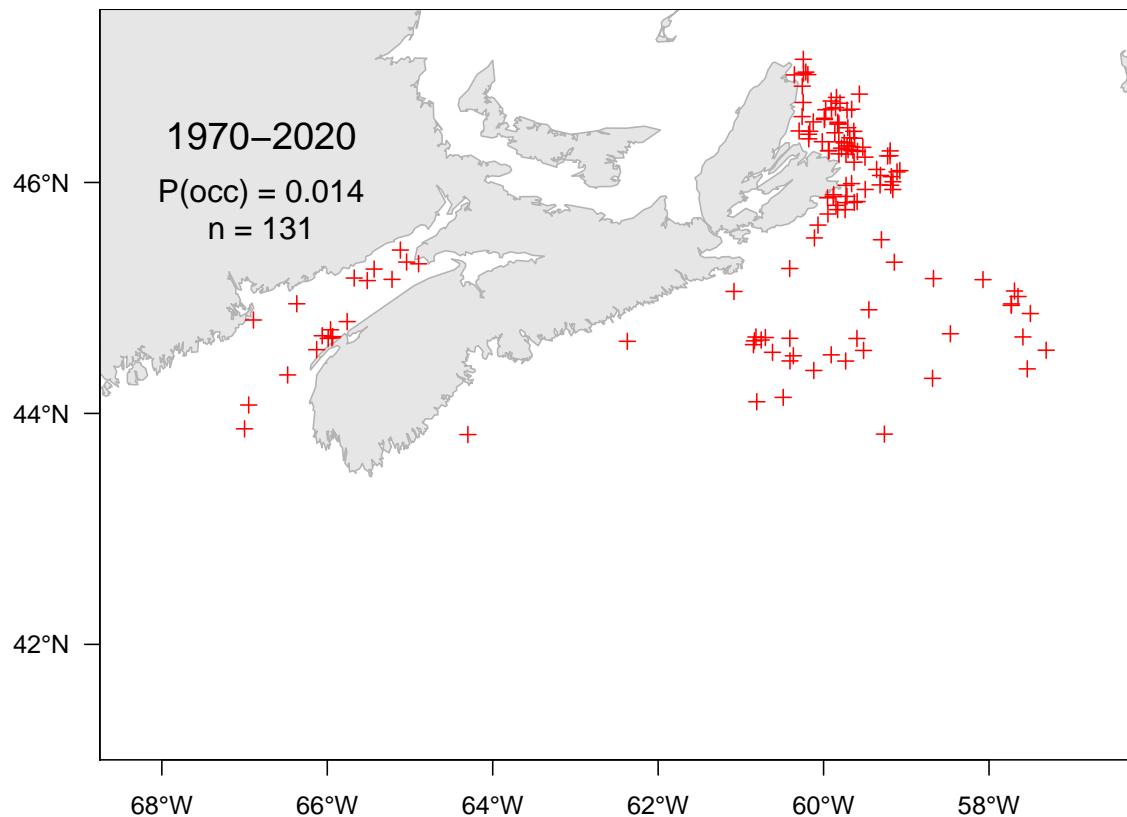


Figure 7.73A. Catch distribution for Shorthorn sculpin.

7.74 Grubby (Chaboisseau bronzé) - species code 303 (category LR)

Scientific name: [Myoxocephalus aenaeus](#)

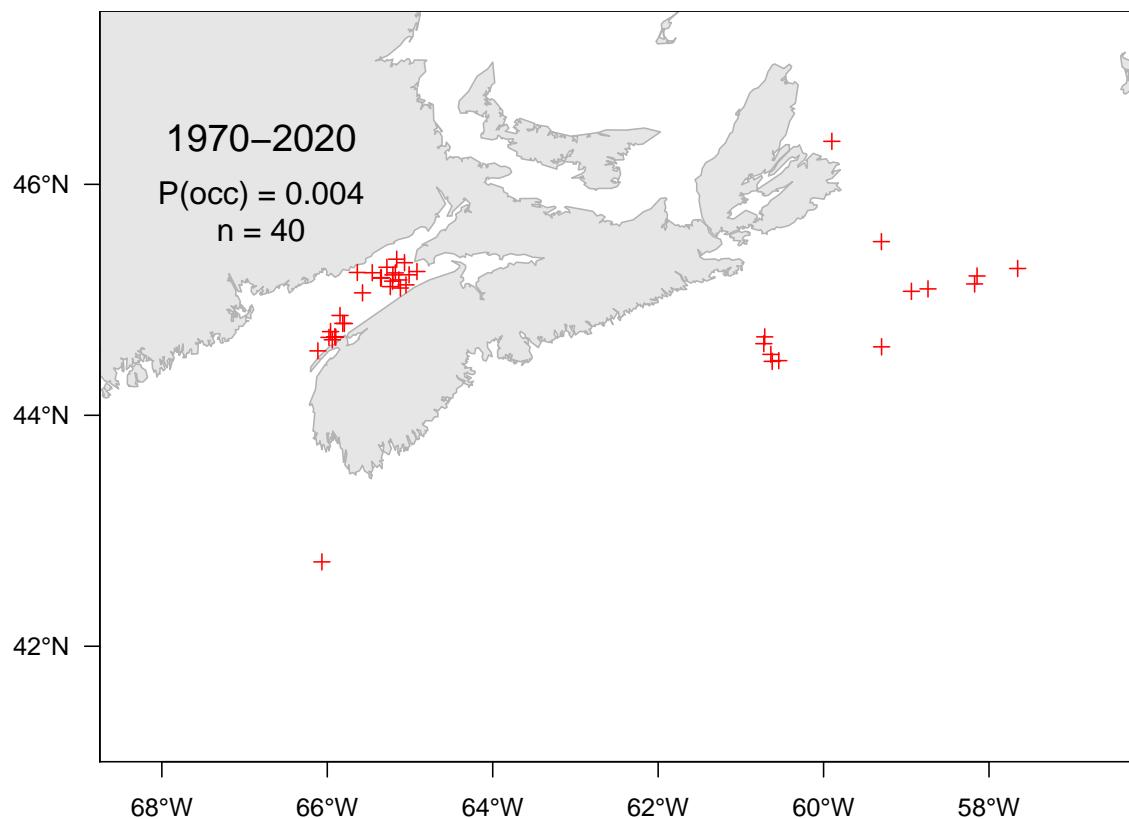


Figure 7.74A. Catch distribution for Grubby.

7.75 Polar sculpin (Cotte polaire) - species code 307 (category LR)

Scientific name: [Cottunculus microps](#)

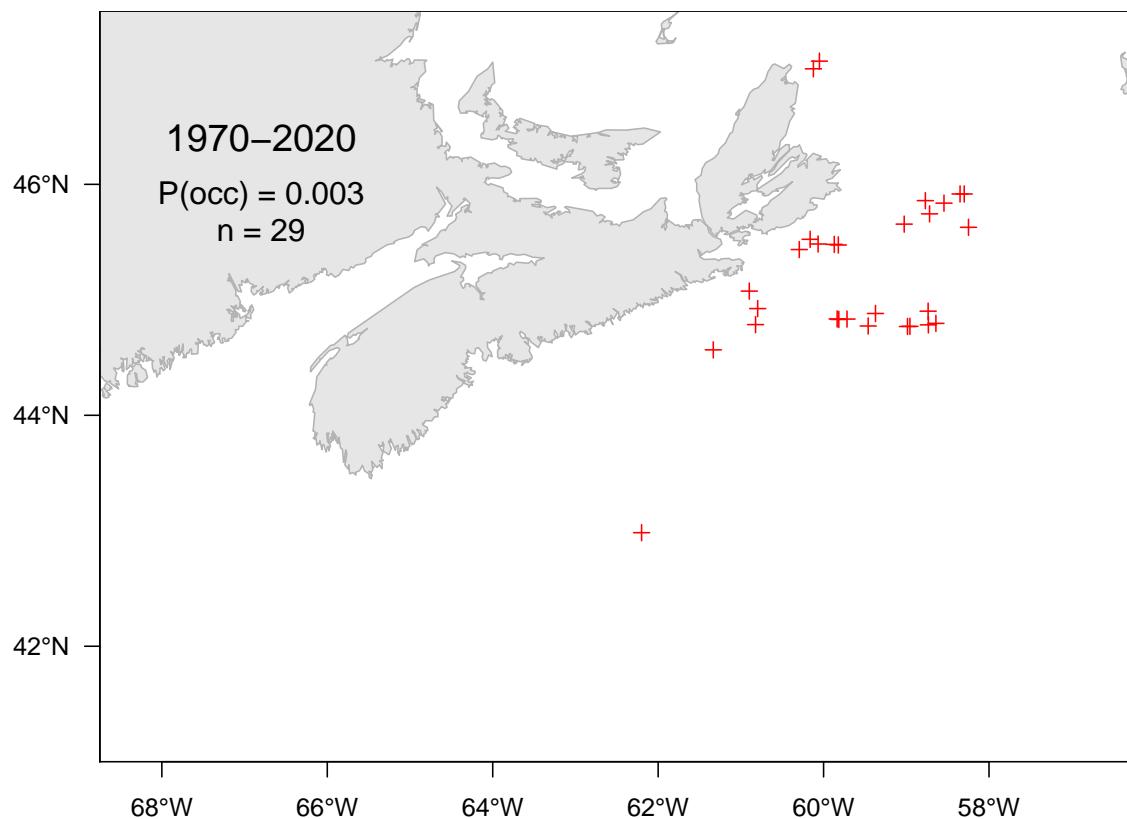


Figure 7.75A. Catch distribution for Polar sculpin.

7.76 Spatulate sculpin (Icèle spatulée) - species code 314 (category LR)

Scientific name: [Icelus spatula](#)

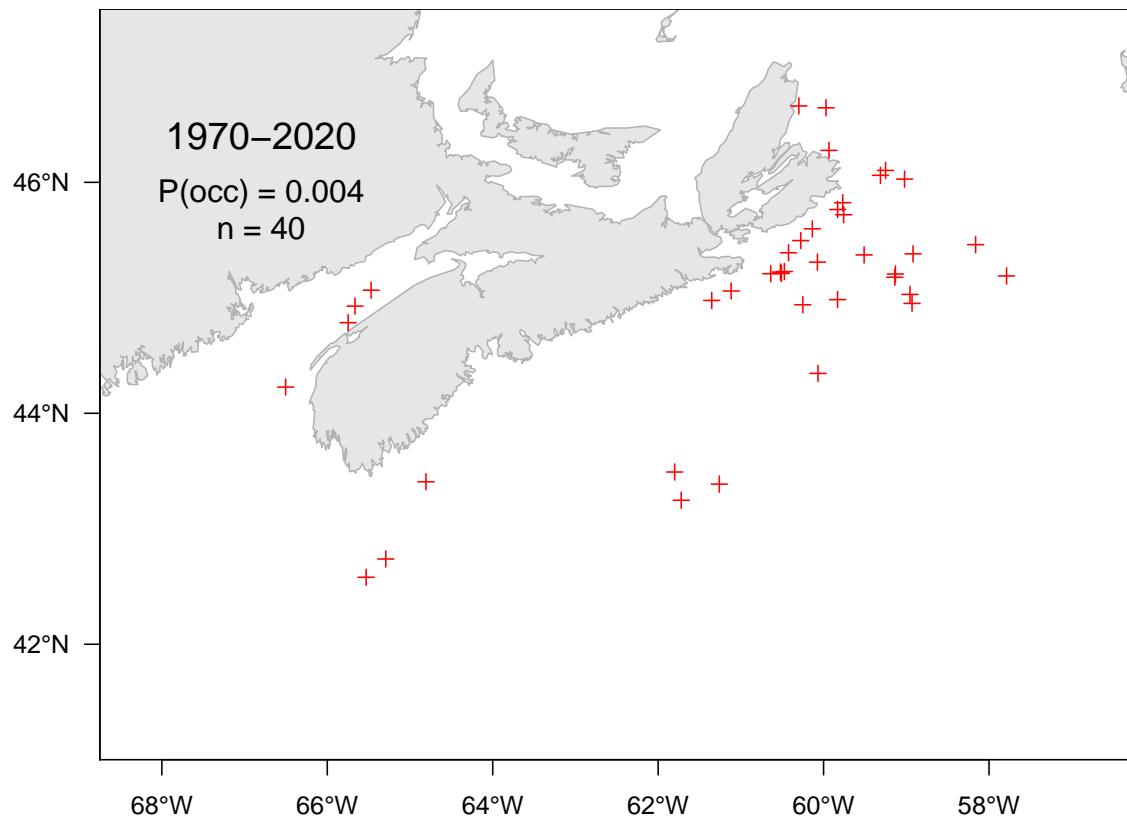


Figure 7.76A. Catch distribution for Spatulate sculpin.

7.77 Arctic alligatorfish (Poisson-alligator arctique) - species code 341 (category LR)

Scientific name: [Ulcina olrikii](#)

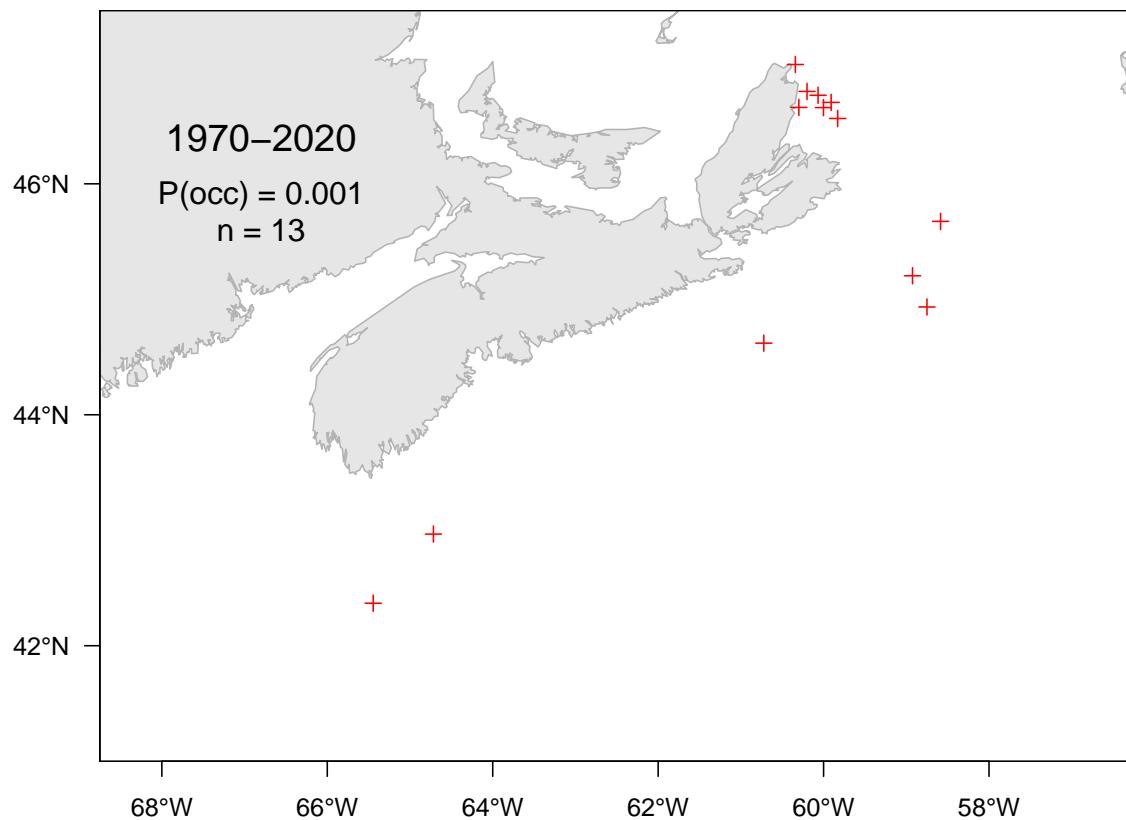


Figure 7.77A. Catch distribution for Arctic alligatorfish.

7.78 Alligatorfishes (Poissons-alligator) - species code 351 (category LR)

Scientific name: [Agonidae](#)

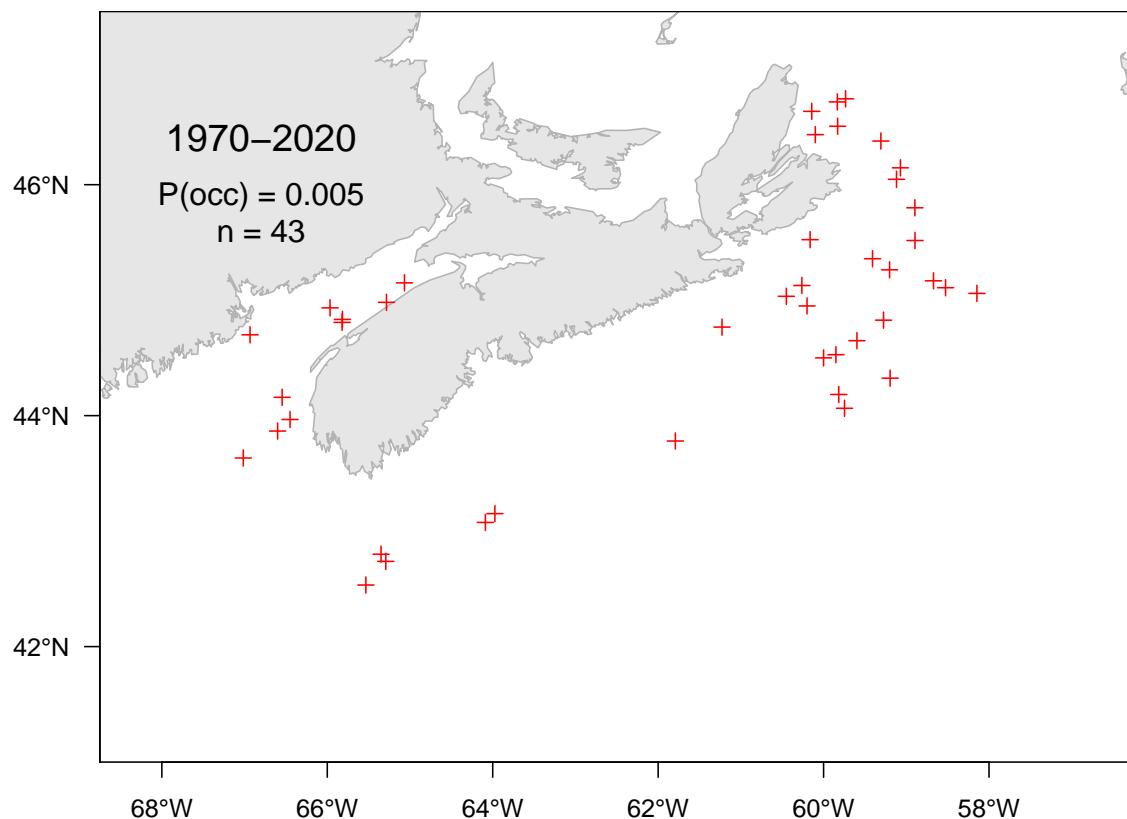


Figure 7.78A. Catch distribution for Alligatorfishes.

7.79 Roughnose grenadier (Grenadier-scie) - species code 412 (category LR)

Scientific name: [Trachyrincus murrayi](#)

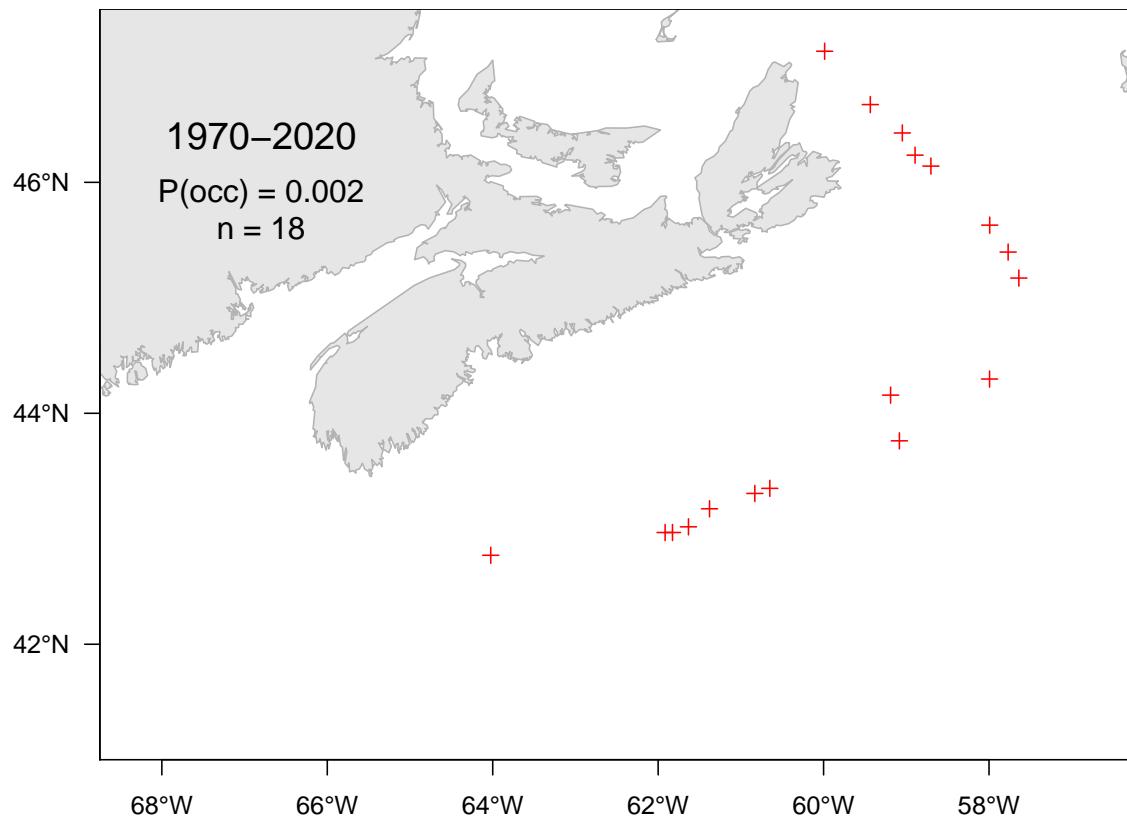


Figure 7.79A. Catch distribution for Roughnose grenadier.

7.80 Roundnose grenadier (Grenadier de roche) - species code 414 (category LR)

Scientific name: [Coryphaenoides rupestris](#)

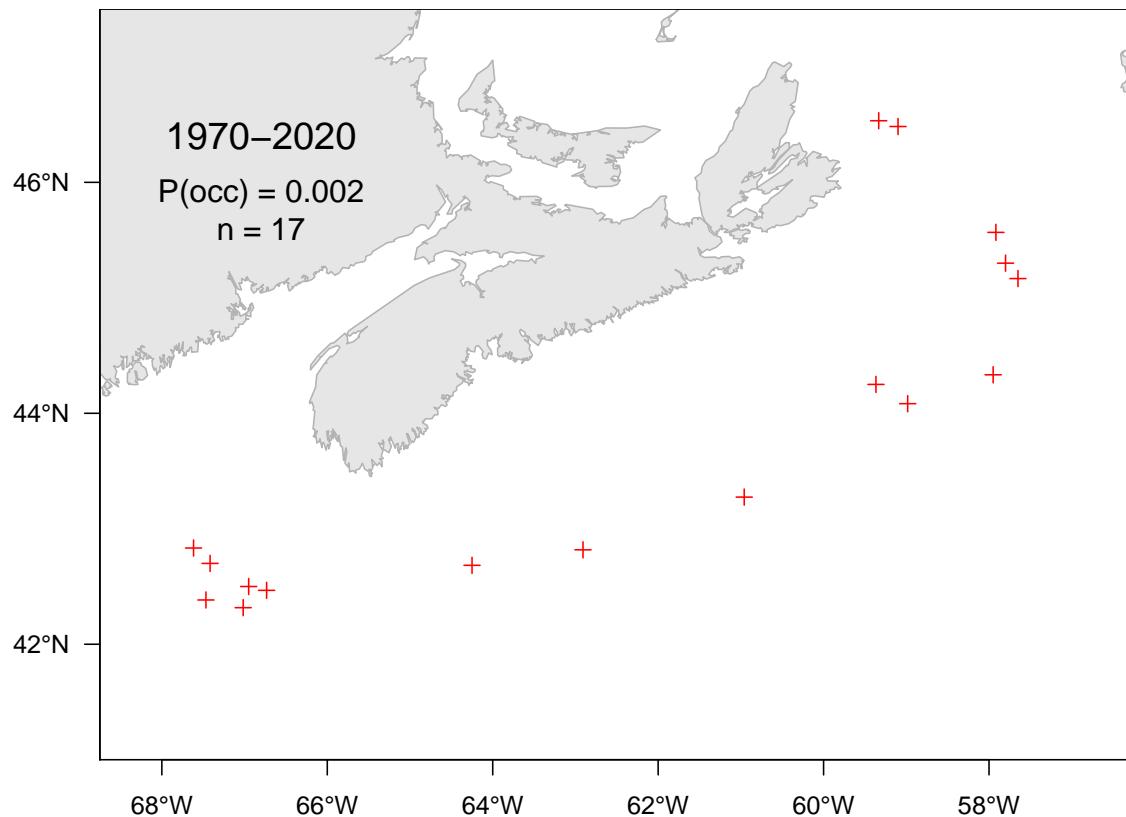


Figure 7.80A. Catch distribution for Roundnose grenadier.

7.81 Atlantic seasnail (*Limace atlantique*) - species code 503 (category LR)

Scientific name: [Liparis atlanticus](#)

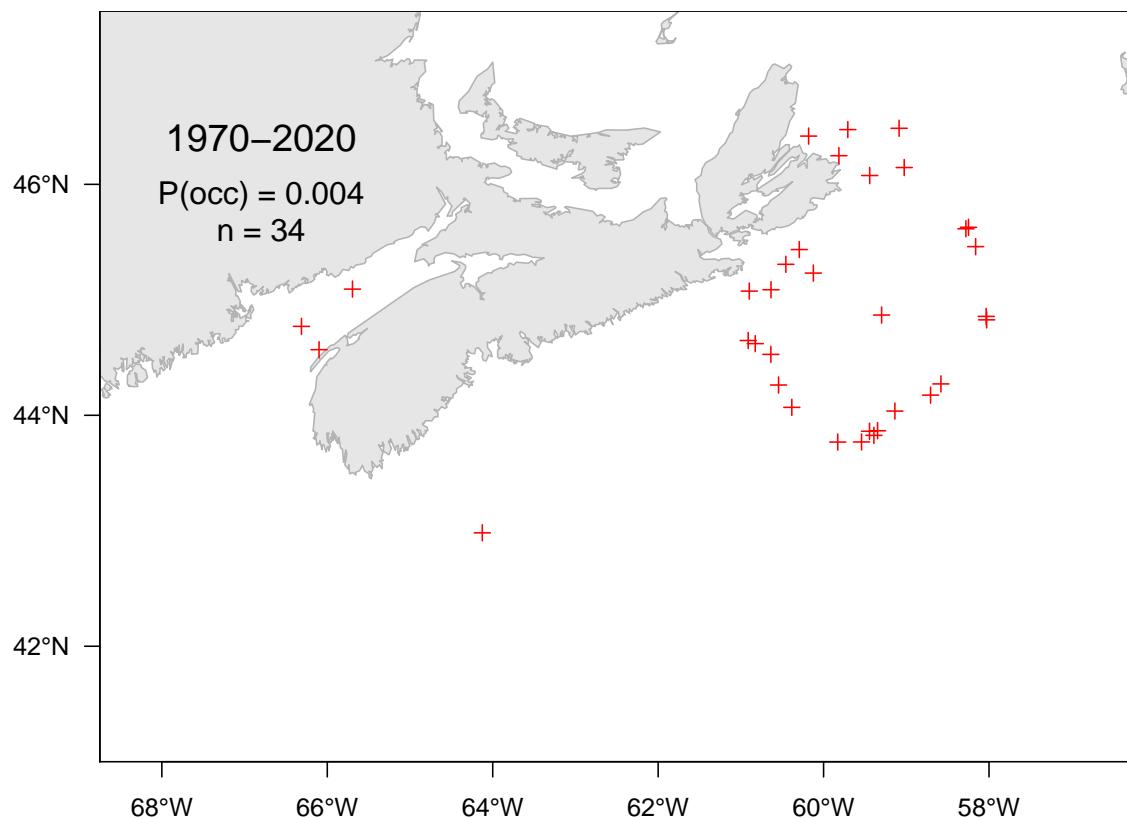


Figure 7.81A. Catch distribution for Atlantic seasnail.

7.82 Gelatinous snailfish (Limace gélatineuse) - species code 505 (category LR)

Scientific name: [Liparis fabricii](#)

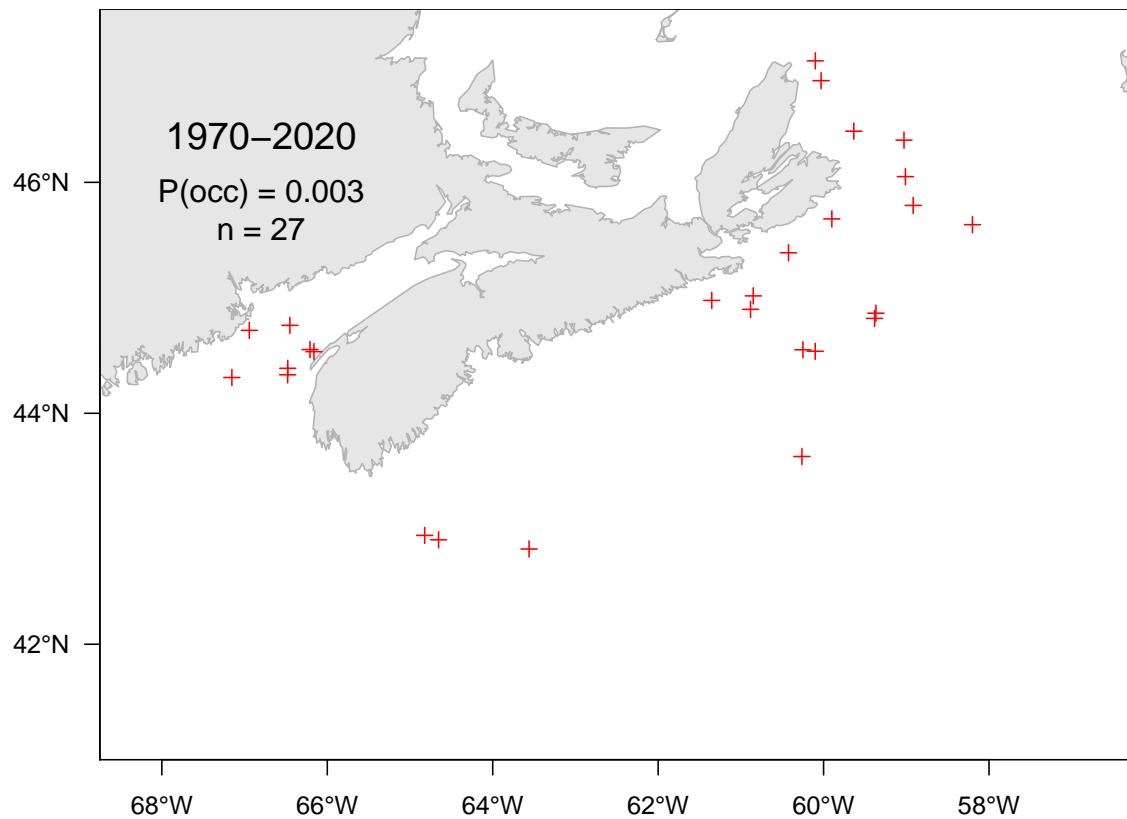


Figure 7.82A. Catch distribution for Gelatinous snailfish.

7.83 Variegated snailfish (*Limace marbée*) - species code 512 (category LR)

Scientific name: [Liparis gibbus](#)

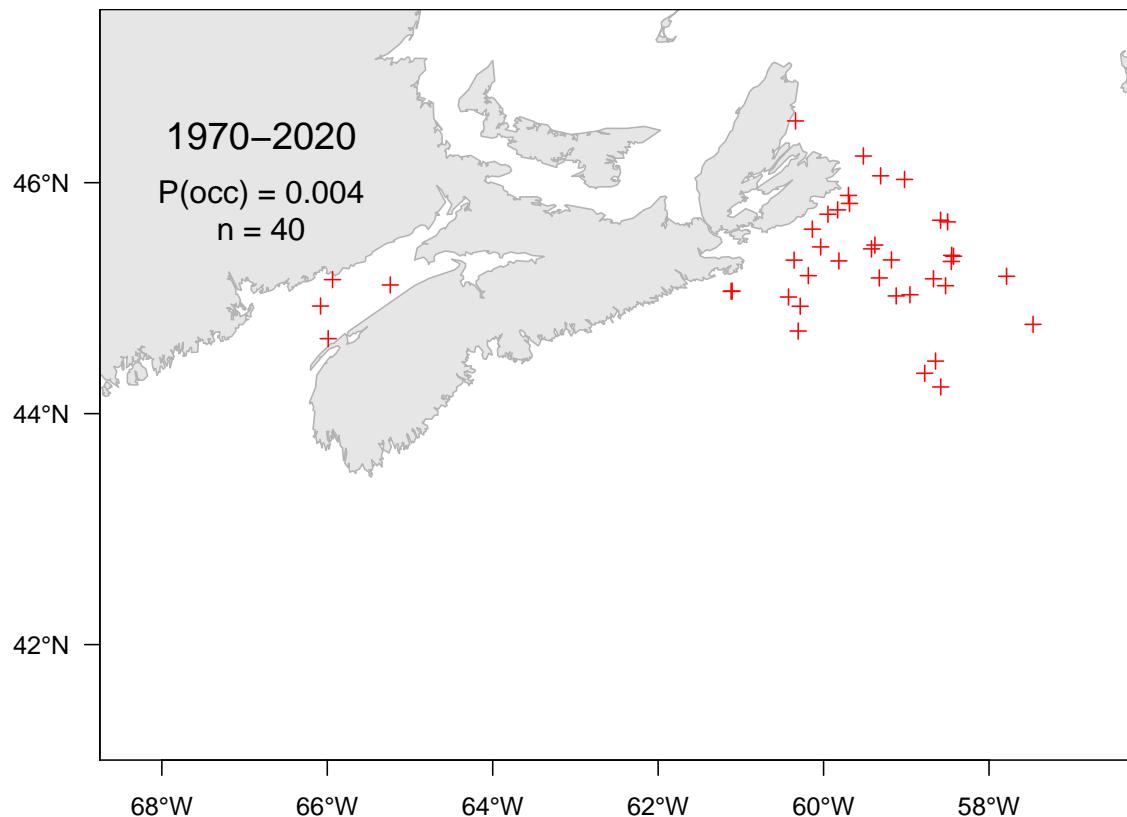


Figure 7.83A. Catch distribution for Variegated snailfish.

7.84 Sea tadpole (Petite limace de mer) - species code 520 (category LR)

Scientific name: [Careproctus reinhardtii](#)

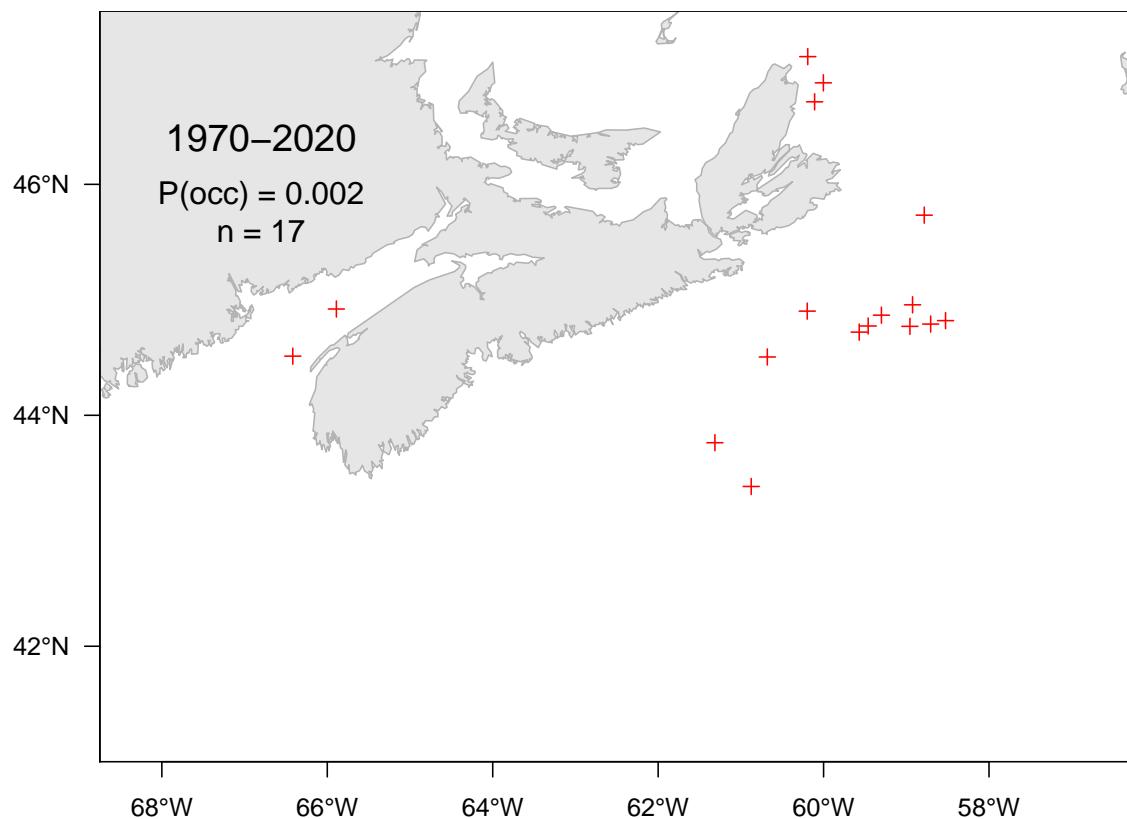


Figure 7.84A. Catch distribution for Sea tadpole.

7.85 Wolf eelpout (*Lycodes à tête longue*) - species code 603 (category LR)

Scientific name: [Lycenchelys verrillii](#)

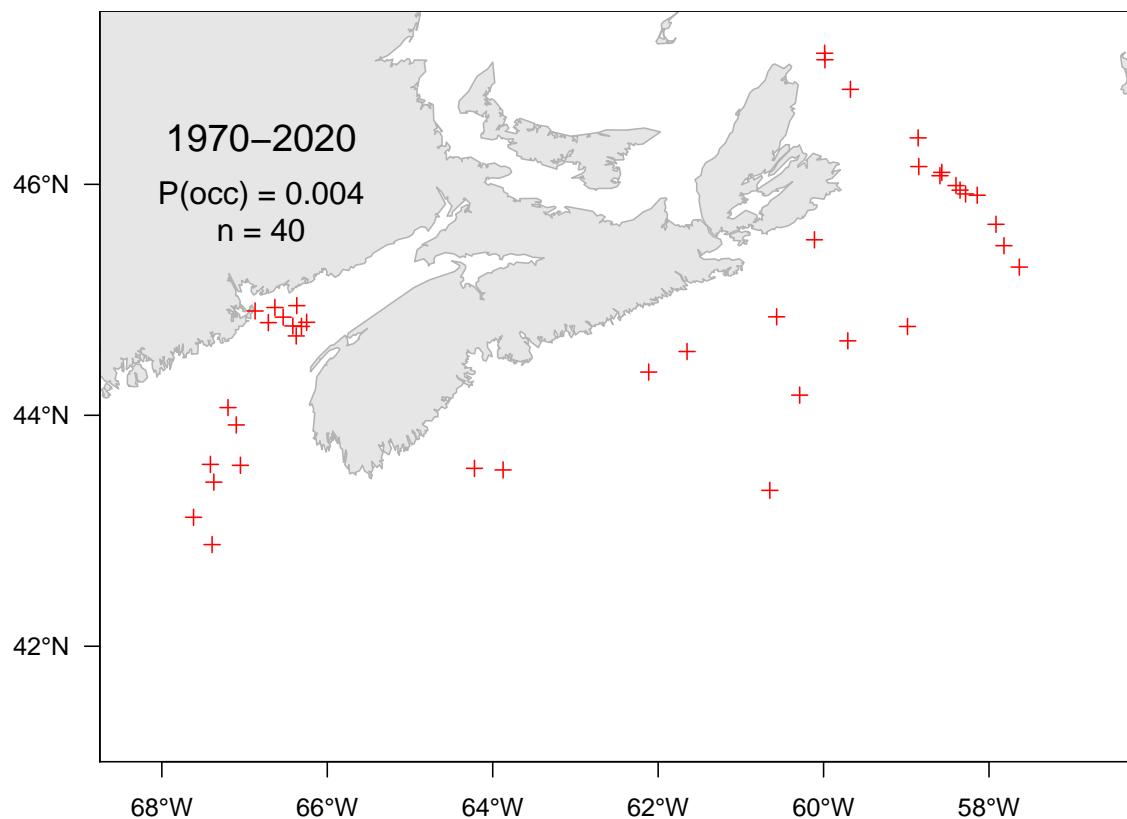


Figure 7.85A. Catch distribution for Wolf eelpout.

7.86 Slender snipe eel (Avocette ruban) - species code 604 (category LR)

Scientific name: [Nemichthys scolopaceus](#)

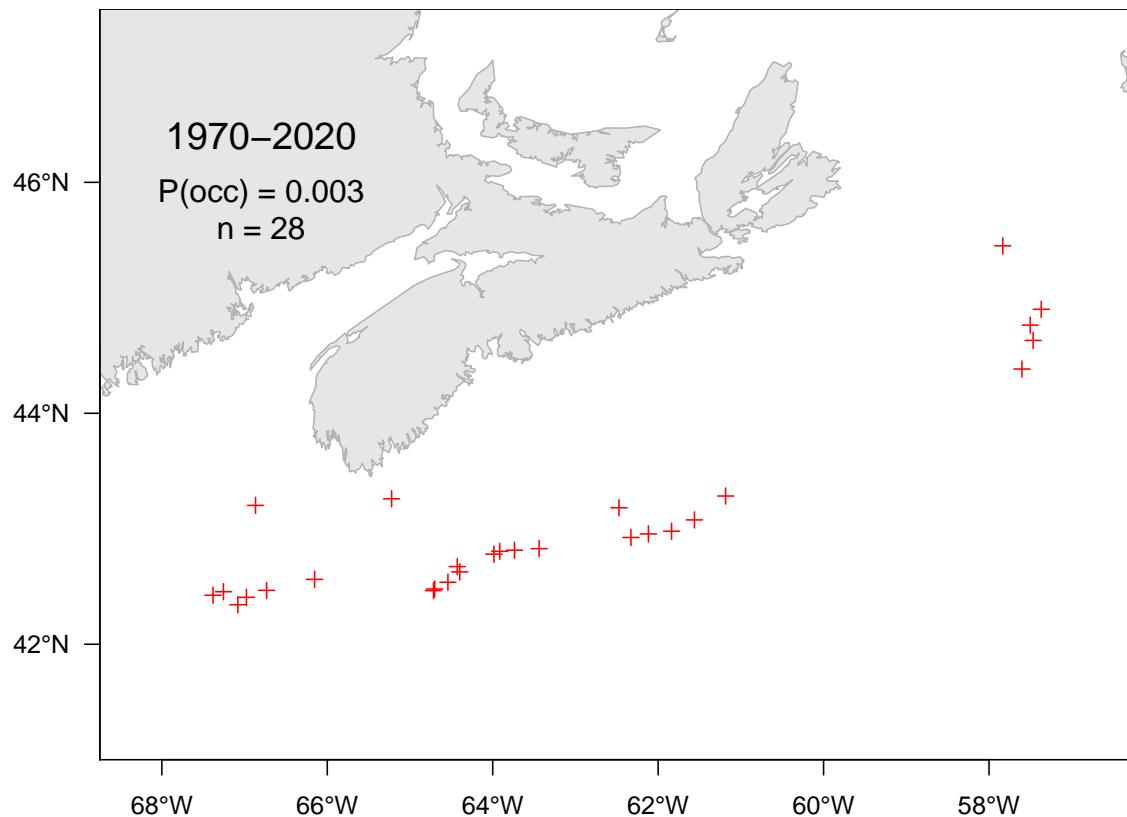


Figure 7.86A. Catch distribution for Slender snipe eel.

7.87 Newfoundland eelpout (Lycodes du Labrador) - species code 619 (category LR)

Scientific name: [Lycodes terraenovae](#)

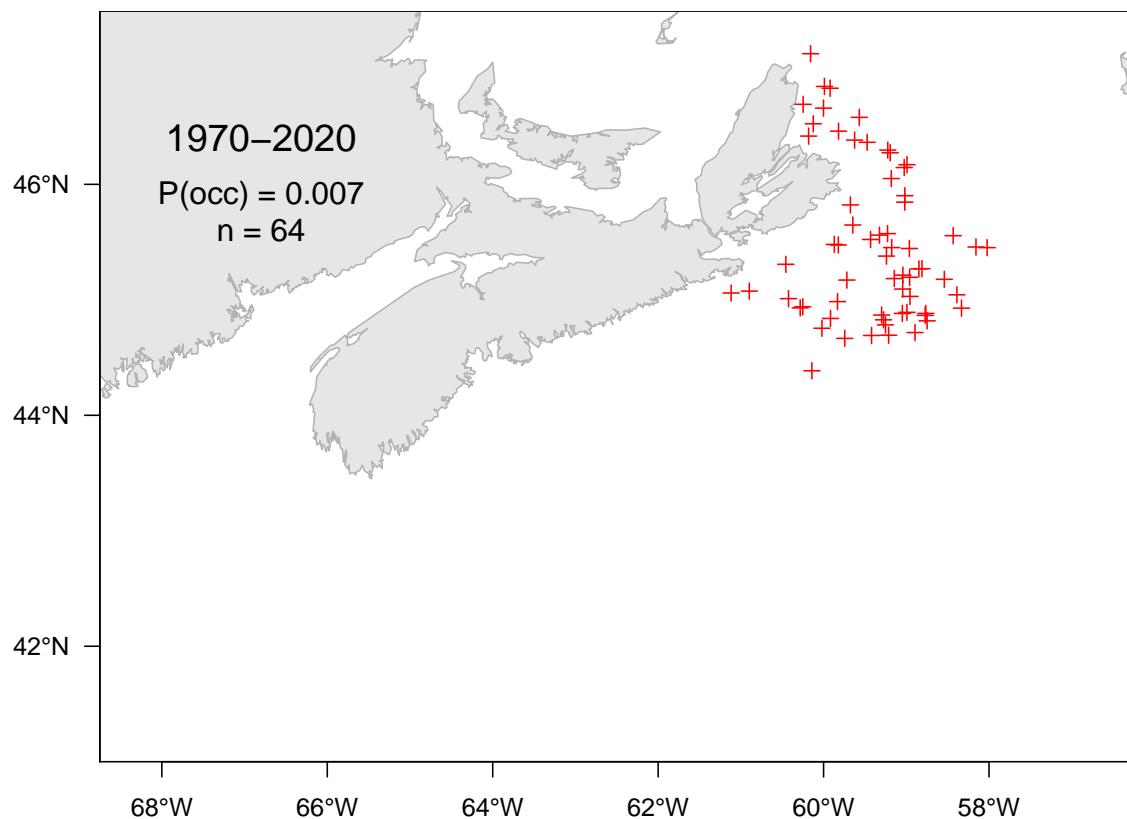


Figure 7.87A. Catch distribution for Newfoundland eelpout.

7.88 Newfoundland eelpout (Lycodes du Labrador) - species code 620 (category LR)

Scientific name: [Lycodes lavalaei](#)

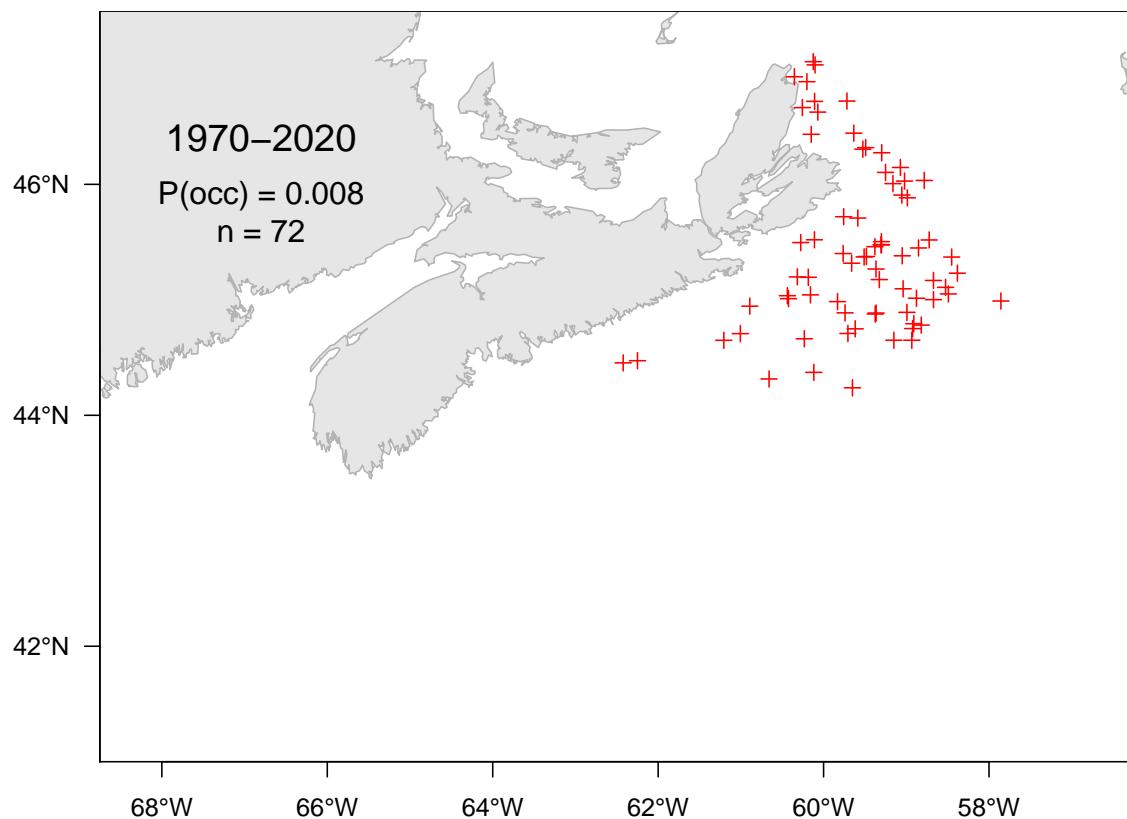


Figure 7.88A. Catch distribution for Newfoundland eelpout.

7.89 Rock gunnel (Sigouine de roche) - species code 621 (category LR)

Scientific name: [Pholis gunnellus](#)

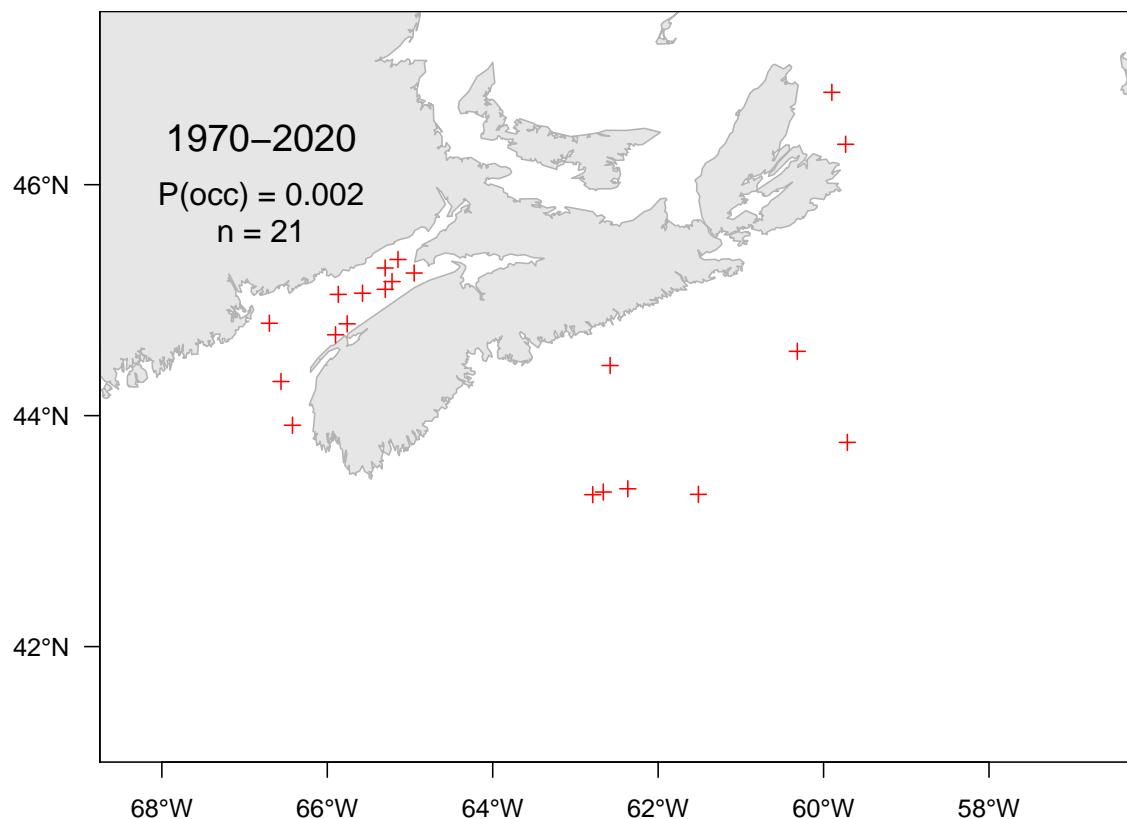


Figure 7.89A. Catch distribution for Rock gunnel.

7.90 Radiated shanny (*Ulvaire deux-lignes*) - species code 625 (category LR)

Scientific name: [Ulvaria subbifurcata](#)

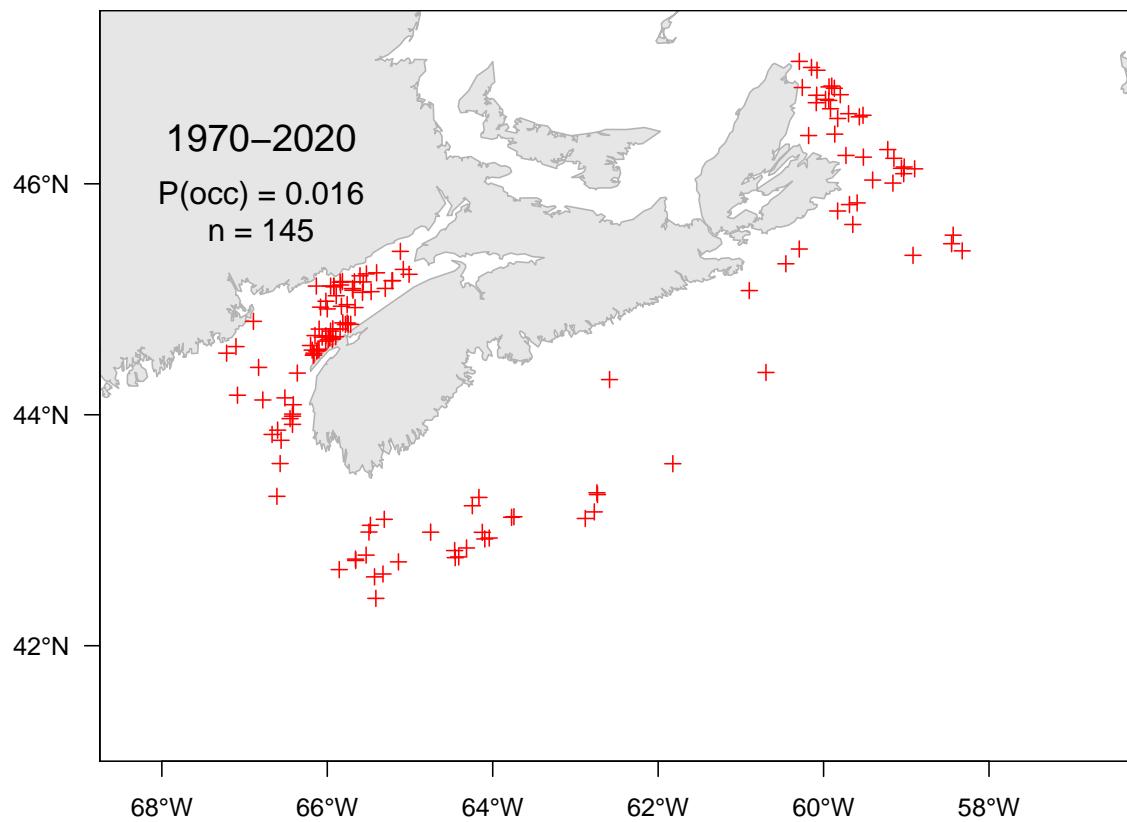


Figure 7.90A. Catch distribution for Radiated shanny.

7.91 Fourline snakeblenny (Quatre-lignes atlantique) - species code 626 (category LR)

Scientific name: [Eumesogrammus praecisus](#)

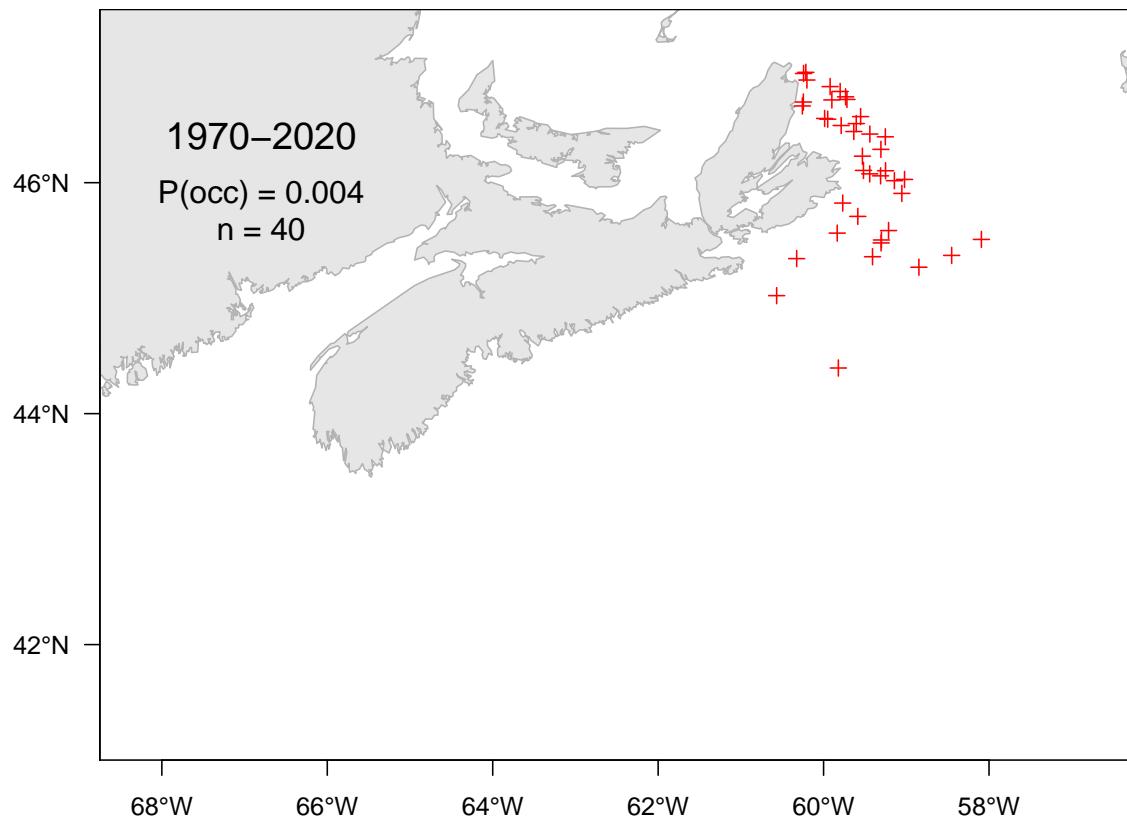


Figure 7.91A. Catch distribution for Fourline snakeblenny.

7.92 Wrymouth (Terrassier tacheté) - species code 630 (category LR)

Scientific name: [Cryptacanthodes maculatus](#)

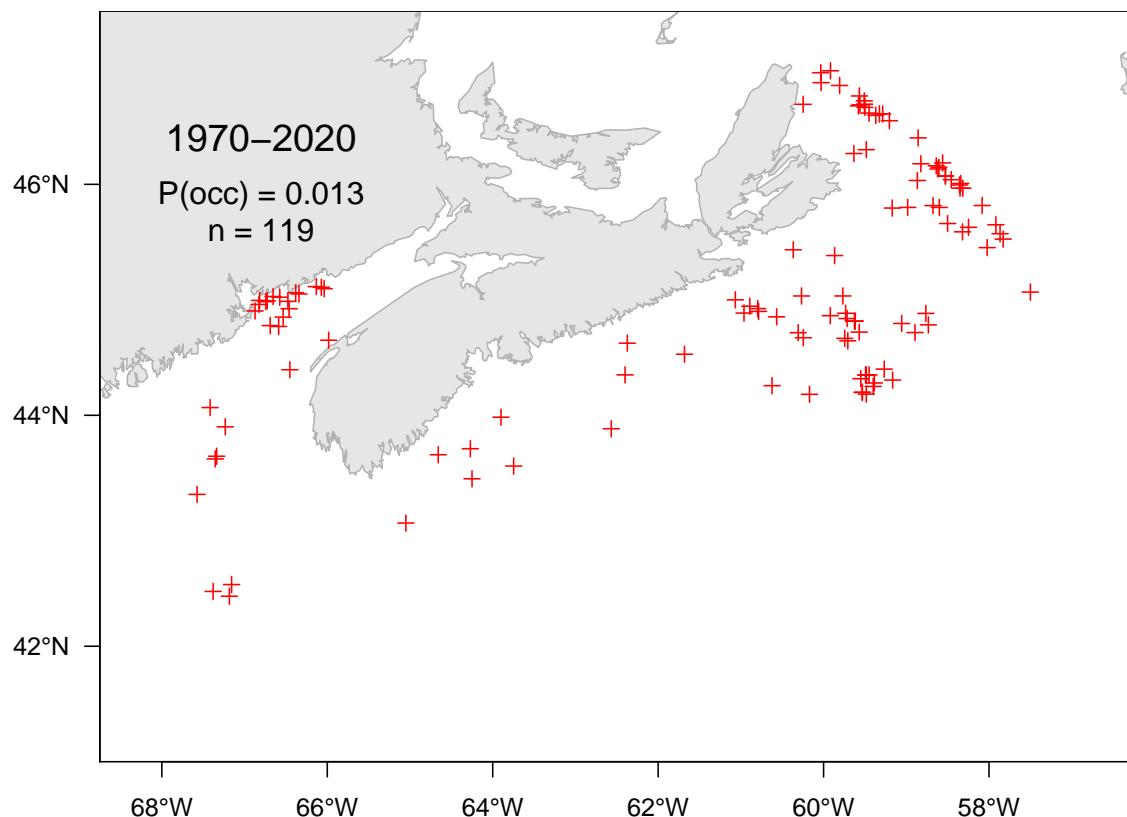


Figure 7.92A. Catch distribution for Wrymouth.

7.93 Spotfin dragonet (Dragonnet tacheté) - species code 637 (category LR)

Scientific name: [Foetorepus agassizii](#)

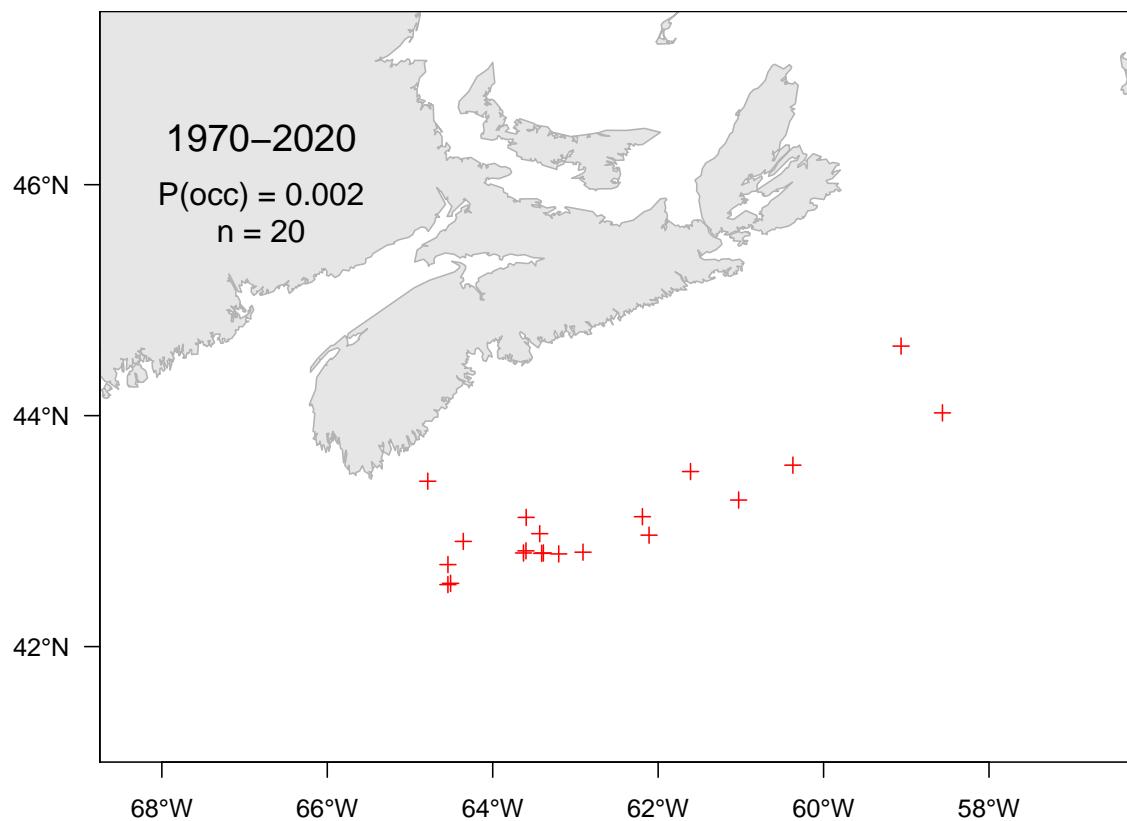


Figure 7.93A. Catch distribution for Spotfin dragonet.

7.94 Arctic eelpout (*Lycodes arctique*) - species code 641 (category LR)

Scientific name: [Lycodes reticulatus](#)

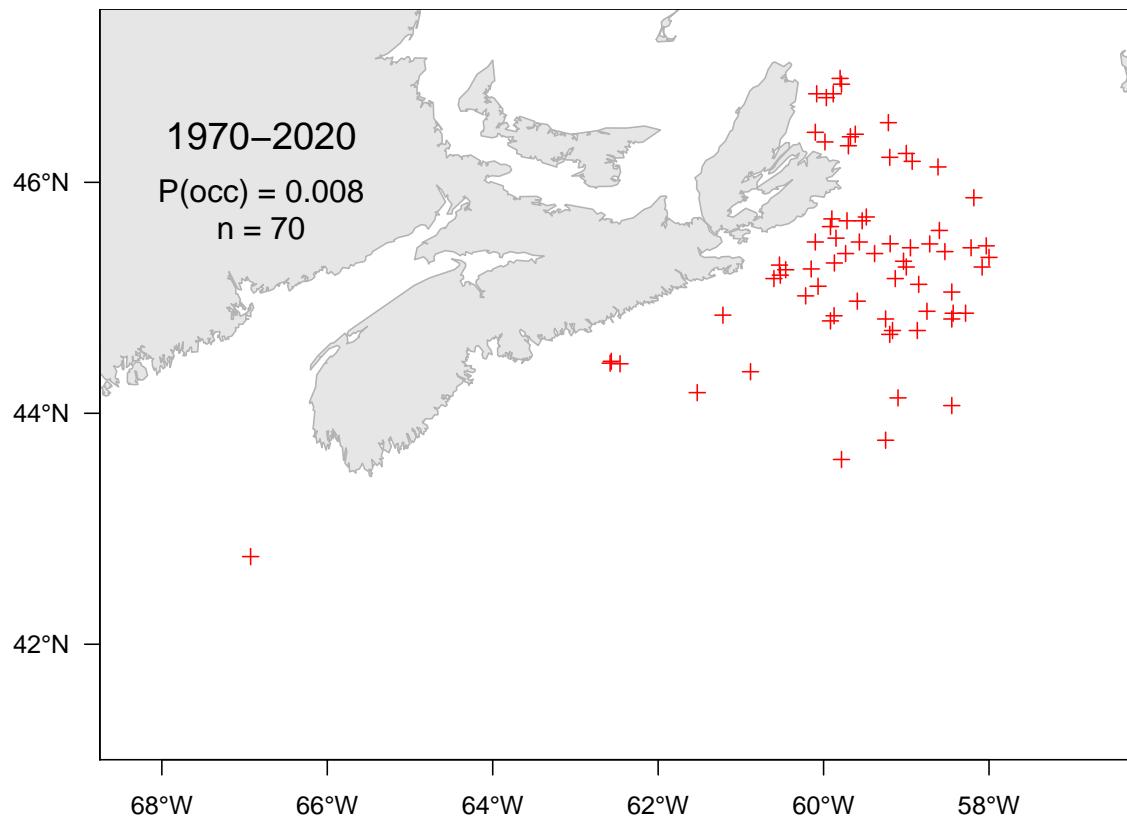


Figure 7.94A. Catch distribution for Arctic eelpout.

7.95 Atlantic soft pout (*Molasse atlantique*) - species code 646 (category LR)

Scientific name: [Melanostigma atlanticum](#)

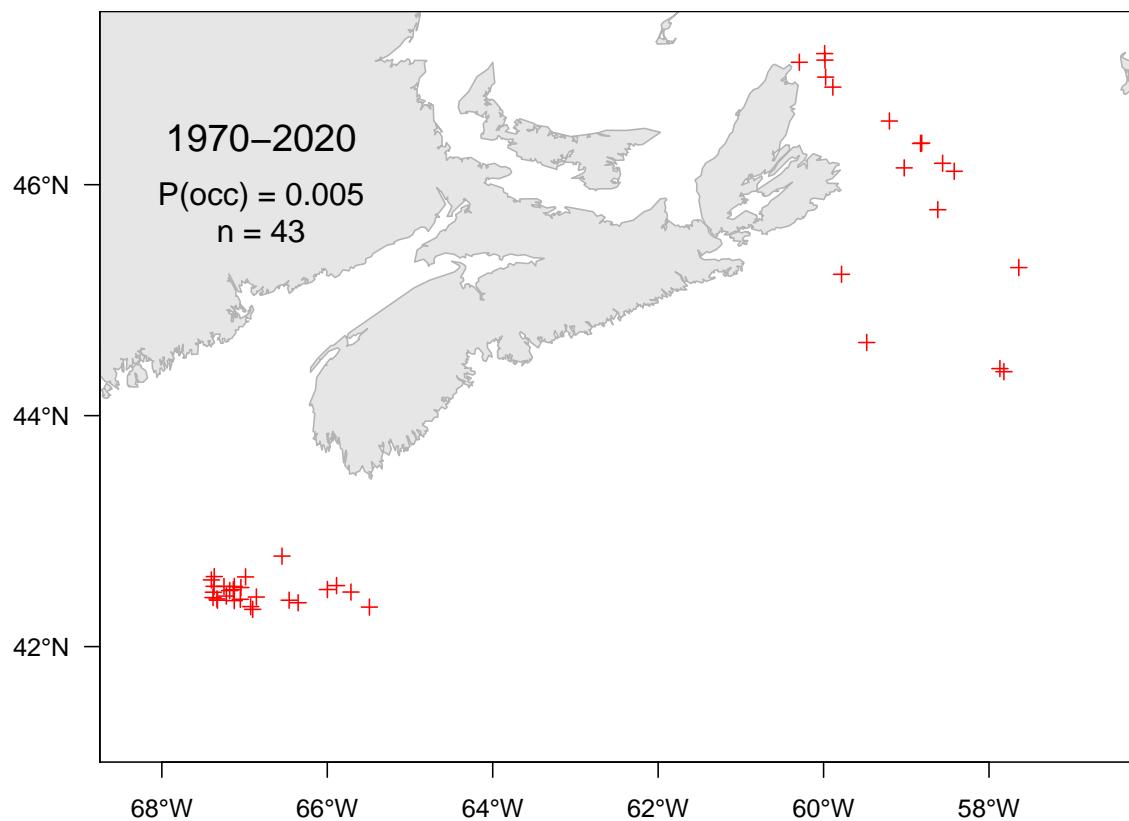


Figure 7.95A. Catch distribution for Atlantic soft pout.

7.96 Silvery John dory (Saint Pierre argenté) - species code 704 (category LR)

Scientific name: [Zenopsis conchifer](#)

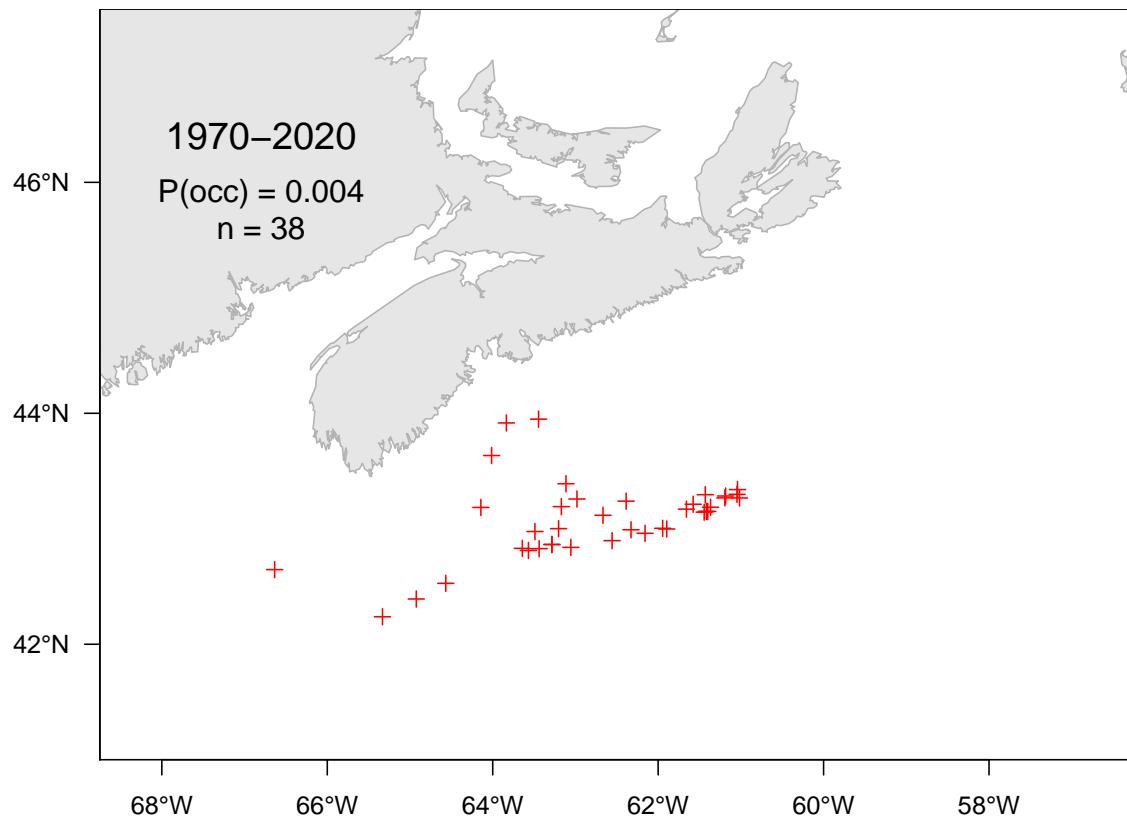


Figure 7.96A. Catch distribution for Silvery John dory.

7.97 White barracudina (*Lussion blanc*) - species code 712 (category LR)

Scientific name: [Arctozenus risso](#)

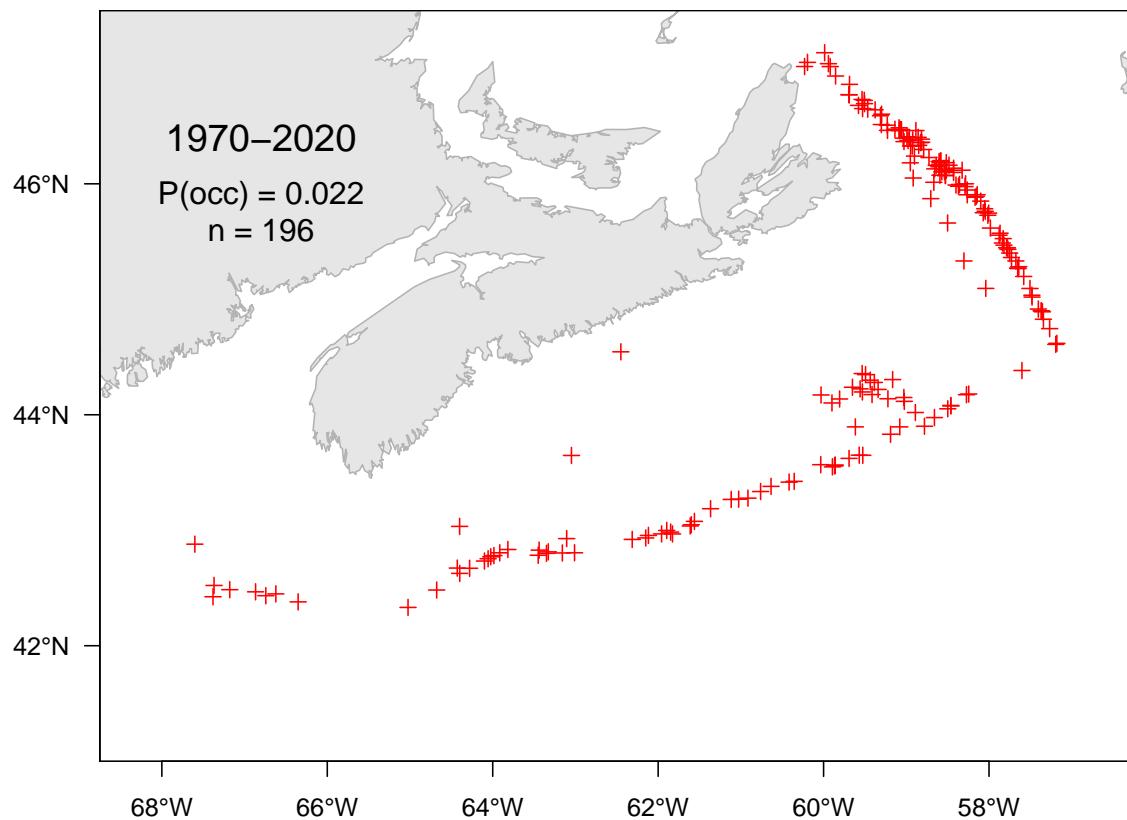


Figure 7.97A. Catch distribution for White barracudina.

7.98 Atlantic saury (Balaou atlantique) - species code 720 (category LR)

Scientific name: [Scomberesox saurus](#)

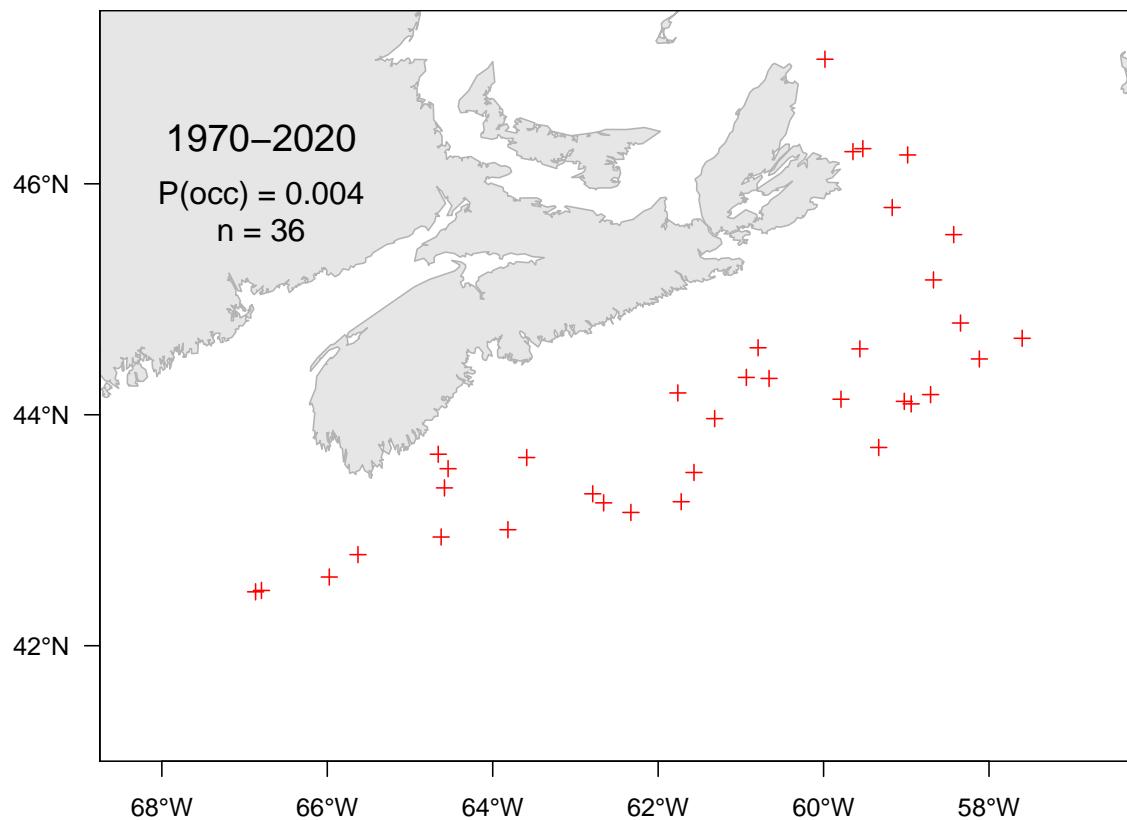


Figure 7.98A. Catch distribution for Atlantic saury.

7.99 Hatchetfishes (Haches d'argent) - species code 741 (category LR)

Scientific name: [Sternopychidae](#)

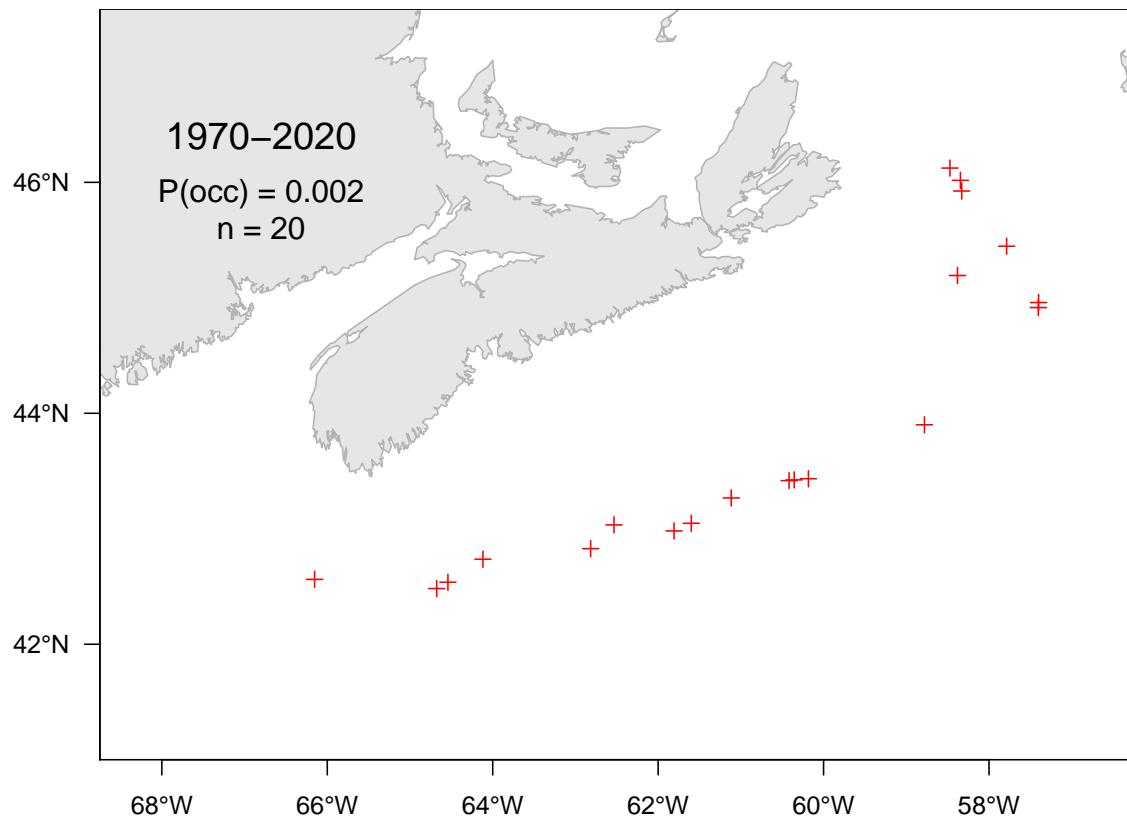


Figure 7.99A. Catch distribution for Hatchetfishes.

7.100 Atlantic batfish (*Malthe atlantique*) - species code 742 (category LR)

Scientific name: [Dibranchus atlanticus](#)

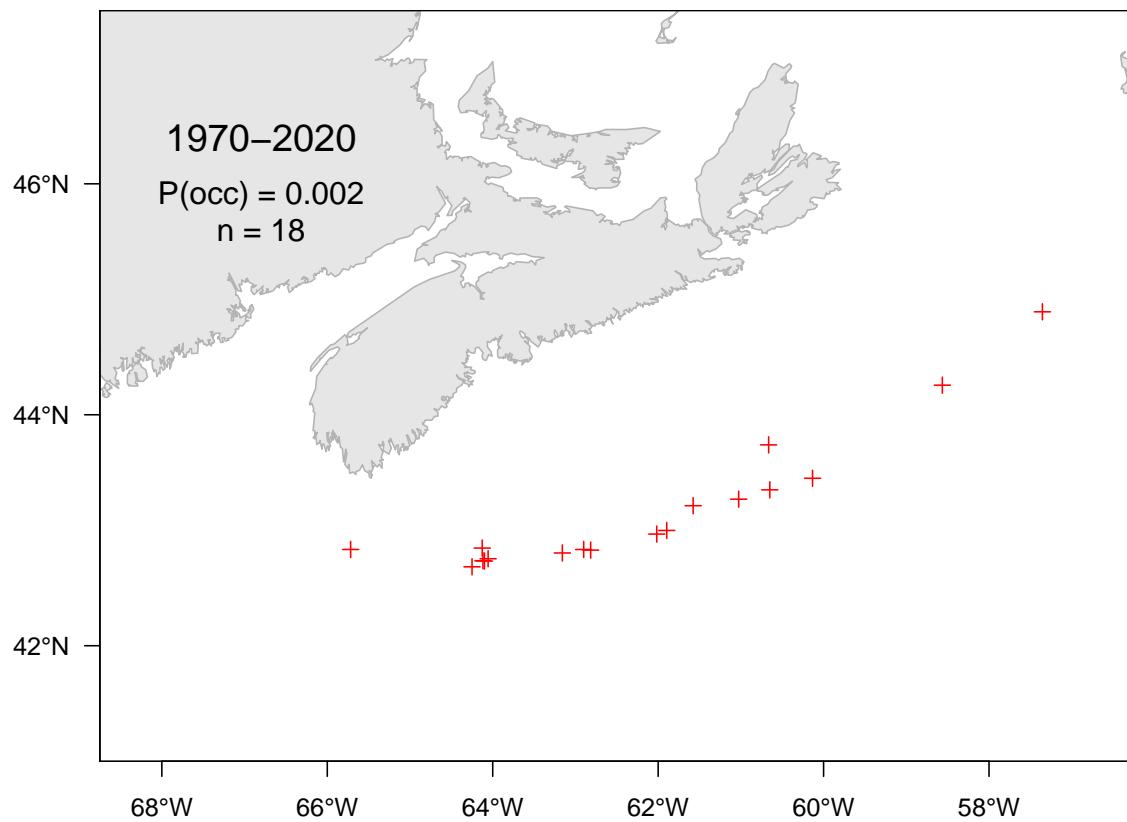


Figure 7.100A. Catch distribution for Atlantic batfish.

7.101 Spottedfin tonguefish (Langue fil noir) - species code 816 (category LR)

Scientific name: [Symphurus diomedeanus](#)

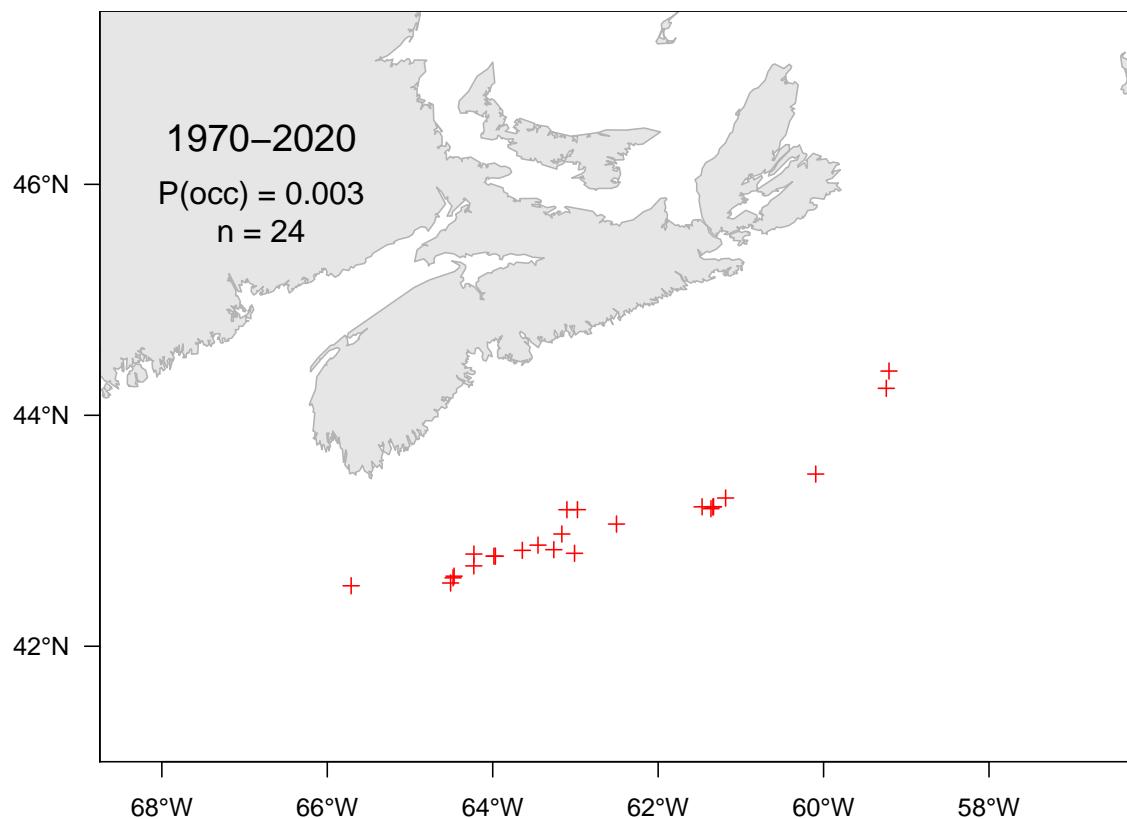


Figure 7.101A. Catch distribution for Spottedfin tonguefish.

7.102 Black dogfish (Aiguillat noir) - species code 221 (category LR)

Scientific name: [Centroscyllium fabricii](#)

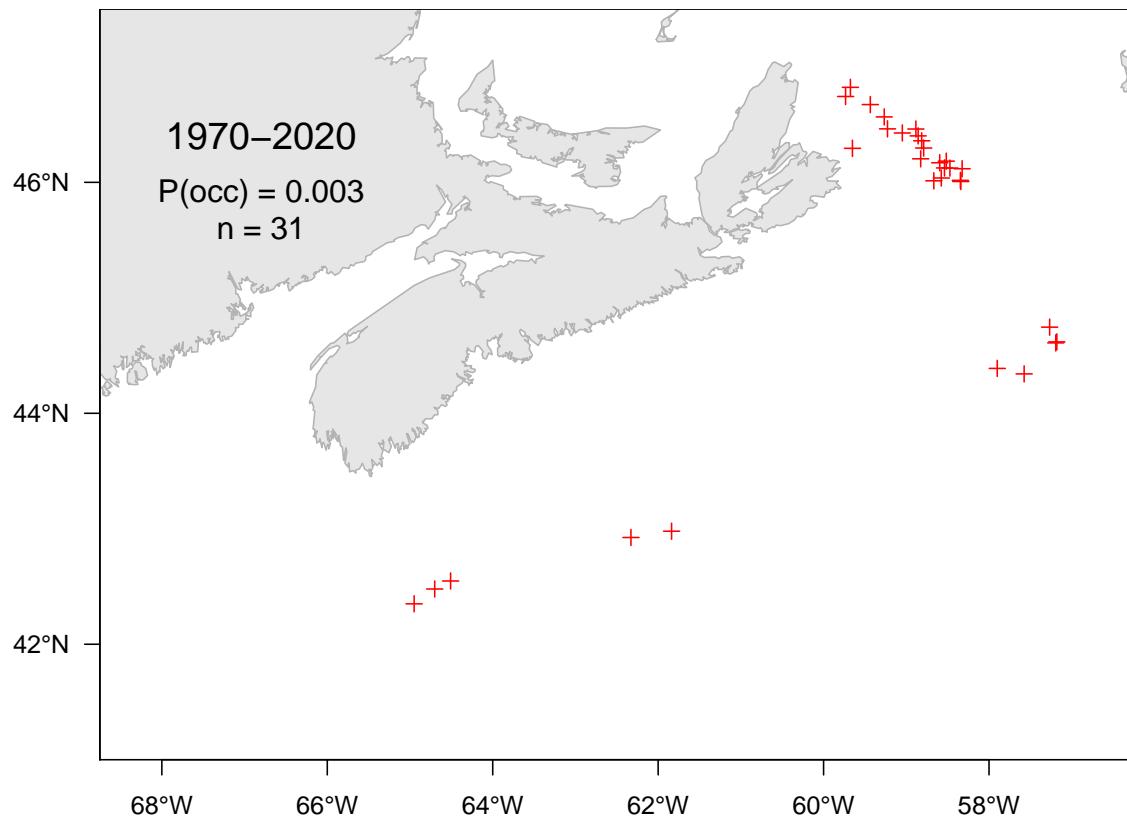


Figure 7.102A. Catch distribution for Black dogfish.

7.103 Longfin inshore squid (*Calmar totam*) - species code 4512 (category LR)

Scientific name: [Doryteuthis pealeii](#)

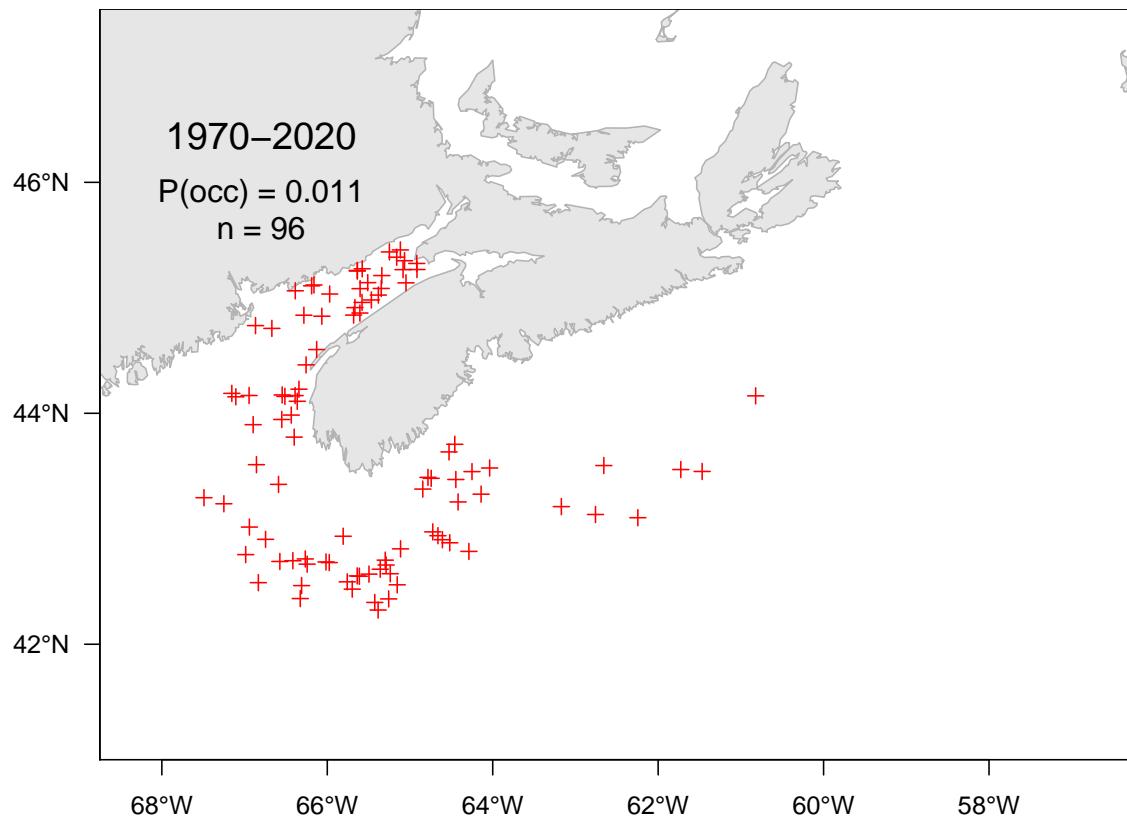


Figure 7.103A. Catch distribution for Longfin inshore squid.

7.104 Red deepsea crab (Crabe rouge) - species code 2532 (category SR)

Scientific name: [Chaceon quinquedens](#)

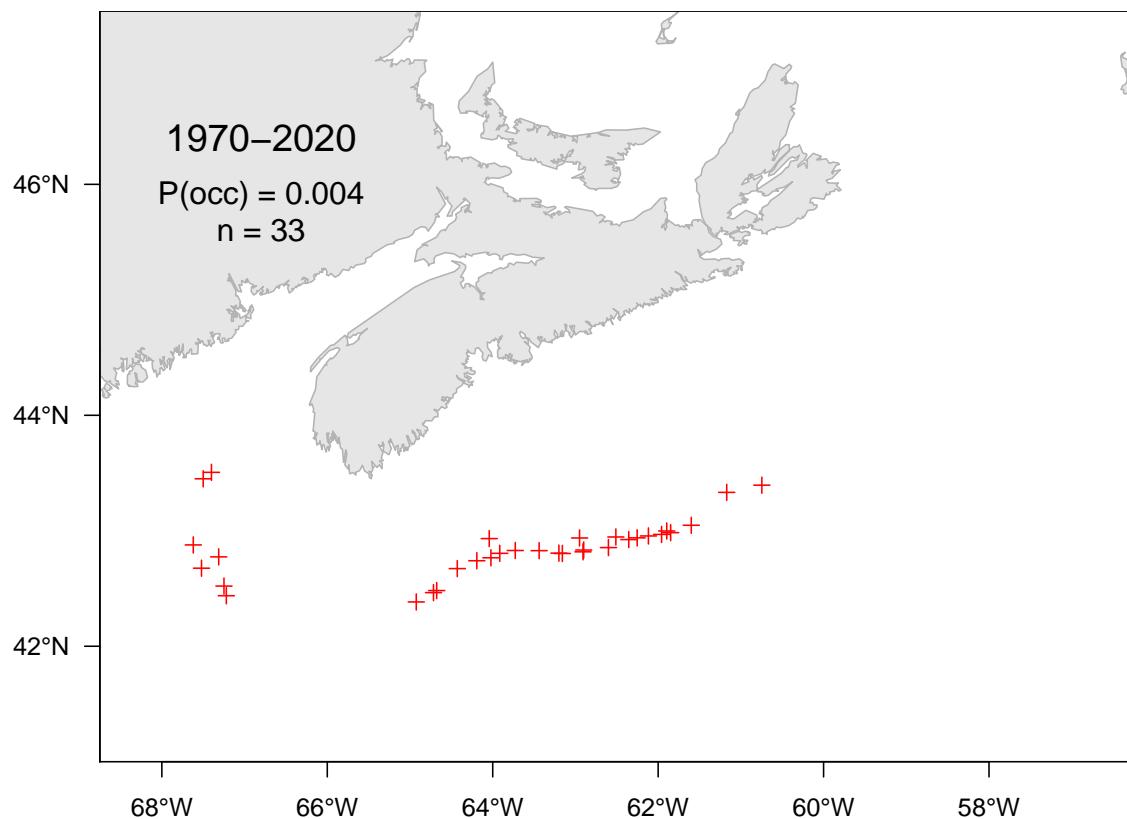


Figure 7.104A. Catch distribution for Red deepsea crab.

INDEX

- Agone atlantique, 113
Agonidae, 152
 Agonidae, 152
 Aspidophoroides monopterygius, 76
 Leptagonus decagonus, 113
 Ulcina olrikii, 151
Aiglefin, 28
Aiguillat commun, 94
Aiguillat noir, 176
Alewife, 105
Alligatorfish, 76
Alligatorfishes, 152
Alosa pseudoharengus, 105
Alosa sapidissima, 104
Alose savoureuse, 104
Ambylyraja radiata, 85
American lobster, 132
American plaice, 49
American shad, 104
Ammodytes dubius, 117
Ammodytidae
 Ammodytes dubius, 117
Anarhichadidae
 Anarhichas denticulatus, 137
 Anarhichas lupus, 61
 Anarhichas minor, 136
Anarhichas denticulatus, 137
Anarhichas lupus, 61
Anarhichas minor, 136
Arctic alligatorfish, 151
Arctic eelpout, 168
Arctic hookear sculpin, 112
Arctic lyre crab, 128
Arctozenus risso, 171
Argentina silus, 111
Argentinidae
 Argentina silus, 111
Artediellus atlanticus, 122
Artediellus uncinatus, 112
Aspidophoroides monopterygius, 76
Atlantic batfish, 174
Atlantic butterfish, 121
Atlantic cod, 25
Atlantic hagfish, 100
Atlantic halibut, 46
Atlantic herring, 64
Atlantic hookear sculpin, 122
Atlantic king crab, 129
Atlantic mackerel, 107
Atlantic poacher, 113
Atlantic redfishes, 43
Atlantic rock crab, 127
Atlantic saury, 172
Atlantic seasnail, 155
Atlantic soft pout, 169
Atlantic spiny lumpsucker, 116
Atlantic tomcod, 134
Atlantic wolffish, 61
Avocette ruban, 160
Balaou atlantique, 172
Barndoor skate, 123
Baudroie d'Amérique, 79
Black dogfish, 176
Blackbelly rosefish, 110
Boa dragonfish, 146
Brosme, 101
Brosme brosme, 101
Brossé améthyste, 145
Callionymidae
 Foetorepus agassizii, 167
Calmar totam, 177
Cancer borealis, 126
Cancer irroratus, 127
Cancridae
 Cancer borealis, 126
 Cancer irroratus, 127
Capelan, 106
Capelin, 106
Cardeau à quatre ocelles, 140
Careproctus reinhardti, 158
Centroscyllium fabricii, 176
Chabosseau bronzé, 148
Chabosseau à dix-huit épines, 67
Chabosseau à épines courtes, 147
Chaceon quinquedens, 178
Chionoecetes opilio, 130
Chlorophthalmidae
 Chlorophthalmus agassizi, 144
 Parasudis truculenta, 142
Chlorophthalmus agassizi, 144

- Citharichthys arctifrons, 103
 Clupea harengus, 64
 Clupeidae
 Alosa pseudoharengus, 105
 Alosa sapidissima, 104
 Clupea harengus, 64
 Coryphaenoides rupestris, 154
 Cotte polaire, 149
 Cottidae
 Artediellus atlanticus, 122
 Artediellus uncinatus, 112
 Icelus spatula, 150
 Myoxocephalus aenaeus, 148
 Myoxocephalus octodecemspinosis, 67
 Myoxocephalus scorpius, 147
 Triglops murrayi, 70
 Cottunculus microps, 149
 Crabe des neiges, 130
 Crabe Hyas coarctatus, 128
 Crabe lyre araignée, 131
 Crabe rouge, 178
 Crabe épineux du nord, 129
 Crevette nordique, 125
 Cryptacanthodes maculatus, 166
 Cryptacanthodidae
 Cryptacanthodes maculatus, 166
 Cunner, 139
 Cusk, 101
 Cyclopteridae
 Cyclopterus lumpus, 115
 Eumicrotremus spinosus, 116
 Cyclopterus lumpus, 115
 Cynoglossidae
 Symphurus diomedeanus, 175
 Daubed shanny, 119
 Dibranchus atlanticus, 174
 Dipturus laevis, 123
 Doryteuthis pealeii, 177
 Dragon-boa, 146
 Dragonnet tacheté, 167
 Enchelyopus cimbrius, 109
 Encornet rouge nordique, 97
 Etmopteridae
 Centroscyllium fabricii, 176
 Eumesogrammus praecisus, 165
 Eumicrotremus spinosus, 116
 Faux-trigle armé, 70
 Flétan de l'Atlantique, 46
 Flétan noir, 102
 Foetorepus agassizii, 167
 Fourbeard rockling, 109
 Fourline snakeblenny, 165
 Fourspot flounder, 140
 Gadidae
 Gadus morhua, 25
 Melanogrammus aeglefinus, 28
 Microgadus tomcod, 134
 Pollachius virens, 40
 Gadus morhua, 25
 Gaspareau, 105
 Gelatinous snailfish, 156
 Geryonidae
 Chaceon quinquedens, 178
 Glyptocephalus cynoglossus, 52
 Goberge, 40
 Grande argentine, 111
 Grande raie, 123
 Great spider crab, 131
 Greater argentine, 111
 Greenland halibut, 102
 Grenadier de roche, 154
 Grenadier du Grand Banc, 114
 Grenadier-scie, 153
 Grubby, 148
 Gulf Stream flounder, 103
 Haches d'argent, 173
 Haddock, 28
 Hameçon atlantique, 122
 Hameçon neigeux, 112
 Hareng de l'Atlantique, 64
 Hatchetfishes, 173
 Helicolenus dactylopterus, 110
 Hemitripteridae
 Hemitripterus americanus, 73
 Hemitripterus americanus, 73
 Hippoglossina oblonga, 140
 Hippoglossoides platessoides, 49
 Hippoglossus hippoglossus, 46
 Homard américain, 132
 Homarus americanus, 132
 Hyas araneus, 131
 Hyas coarctatus, 128

- Hémitriptère atlantique, 73
- Icelus spatula, 150
Icèle spatulée, 150
Illex illecebrosus, 97
- Jonah crab, 126
- Labridae
 Tautogolabrus adspersus, 139
- Lamproie marine, 133
- Langue fil noir, 175
- Lanternfishes, 143
- Laçon, 117
- Leptagonus decagonus, 113
- Leptoclinus maculatus, 119
- Leucoraja erinacea, 124
- Leucoraja ocellata, 91
- Limace atlantique, 155
- Limace gélatineuse, 156
- Limace marbée, 157
- Limanda ferruginea, 55
- Limande à queue jaune, 55
- Limande-plie rouge, 58
- Liparidae
 Careproctus reinhardtii, 158
 Liparis atlanticus, 155
 Liparis fabricii, 156
 Liparis gibbus, 157
- Liparis atlanticus, 155
- Liparis fabricii, 156
- Liparis gibbus, 157
- Lithodes maja, 129
- Lithodidae
 Lithodes maja, 129
- Little skate, 124
- Lolinidae
 Doryteuthis pealeii, 177
- Lompe, 115
- Lompénie tachetée, 119
- Lompénie-serpent, 118
- Longfin hake, 108
- Longfin inshore squid, 177
- Longhorn sculpin, 67
- Longnose greeneye, 142
- Lophiidae
 Lophius americanus, 79
- Loquette d'Amérique, 82
- Lotidae
 Brosme brosme, 101
 Enchelyopus cimbrius, 109
- Loup atlantique, 61
- Loup tacheté, 136
- Loup à tête large, 137
- Lumpenus lampretaeformis, 118
- Lumpfish, 115
- Lussion blanc, 171
- Lycenchelys verrillii, 159
- Lycore arctique, 168
- Lycore du Labrador, 161, 162
- Lycore à carreaux, 120
- Lycore à tête longue, 159
- Lycodes lavalaei, 162
- Lycodes reticulatus, 168
- Lycodes terraenovae, 161
- Lycodes vahlii, 120
- Macrouridae
 Coryphaenoides rupestris, 154
 Nezumia bairdii, 114
 Trachyrincus murrayi, 153
- Malacoraja senta, 88
- Mallotus villosus, 106
- Malthe atlantique, 174
- Maquereau commun, 107
- Marlin-spike grenadier, 114
- Maurolicus muelleri, 145
- Melanogrammus aeglefinus, 28
- Melanostigma atlanticum, 169
- Merlu argenté, 37
- Merlu argenté du large, 135
- Merlucciidae
 Merluccius albidus, 135
 Merluccius bilinearis, 37
- Merluccius albidus, 135
- Merluccius bilinearis, 37
- Merluche blanche, 31
- Merluche à longues nageoires, 108
- Merluche écureuil, 34
- Microgadus tomcod, 134
- Molasse atlantique, 169
- Monkfish, 79
- Morue franche, 25
- Motelle à quatre barbillons, 109
- Moustache sculpin, 70

- Myctophidae, 143
 - Myctophidae, 143
- Myoxocephalus aenaeus, 148
- Myoxocephalus octodecemspinosis, 67
- Myoxocephalus scorpius, 147
- Myxine du nord, 100
- Myxine glutinosa, 100
- Myxinidae
 - Myxine glutinosa, 100
- Nemichthyidae
 - Nemichthys scolopaceus, 160
- Nemichthys scolopaceus, 160
- Nephropidae
 - Homarus americanus, 132
- Newfoundland eelpout, 161, 162
- Nezumia bairdii, 114
- Northern prawn, 125
- Northern shortfin squid, 97
- Northern wolffish, 137
- Ocean pout, 82
- Oeil-vert à long nez, 142
- Offshore silver hake, 135
- Ogcocephalidae
 - Dibranchus atlanticus, 174
- Ommastrephidae
 - Illex illecebrosus, 97
- Oregoniidae
 - Chionoecetes opilio, 130
 - Hyas araneus, 131
 - Hyas coarctatus, 128
- Osmeridae
 - Mallotus villosus, 106
 - Osmerus mordax, 138
- Osmerus mordax, 138
- Pandalidae
 - Pandalus borealis, 125
- Pandalus borealis, 125
- Paralepididae
 - Arctozenus risso, 171
- Paralichthyidae
 - Citharichthys arctifrons, 103
 - Hippoglossina oblonga, 140
- Parasudis triculenta, 142
- Peprilus triacanthus, 121
- Petite limace de mer, 158
- Petite poule de mer atlantique, 116
- Petromyzon marinus, 133
- Petromyzontidae
 - Petromyzon marinus, 133
- Pholidae
 - Pholis gunnellus, 163
- Pholis gunnellus, 163
- Phycidae
 - Phycis chesteri, 108
 - Urophycis chuss, 34
 - Urophycis tenuis, 31
- Phycis chesteri, 108
- Picked dogfish, 94
- Pleuronectidae
 - Glyptocephalus cynoglossus, 52
 - Hippoglossoides platessoides, 49
 - Hippoglossus hippoglossus, 46
 - Limanda ferruginea, 55
 - Pseudopleuronectes americanus, 58
 - Reinhardtius hippoglossoides, 102
- Plie canadienne, 49
- Plie du Gulf Stream, 103
- Plie grise, 52
- Poisson-alligator arctique, 151
- Poisson-alligator atlantique, 76
- Poissons-alligator, 152
- Poissons-lanternes, 143
- Polar sculpin, 149
- Pollachius virens, 40
- Pollock, 40
- Poulamon atlantique, 134
- Pseudopleuronectes americanus, 58
- Psychrolutidae
 - Cottunculus microps, 149
- Quatre-lignes atlantique, 165
- Queen crab, 130
- Radiated shanny, 164
- Raie hérisson, 124
- Raie lisse, 88
- Raie tachetée, 91
- Raie épineuse, 85
- Rainbow smelt, 138
- Rajidae
 - Amblyraja radiata, 85
 - Dipturus laevis, 123
 - Leucoraja erinacea, 124

- Leucoraja ocellata, 91
- Malacoraja senta, 88
- Red deepsea crab, 178
- Red hake, 34
- Reinhardtius hippoglossoides, 102
- Rock gunnel, 163
- Roughnose grenadier, 153
- Roundnose grenadier, 154
- Saint Pierre argenté, 170
- Sand lance, 117
- Scomber scombrus, 107
- Scomberesocidae
 - Scomberesox saurus, 172
- Scomberesox saurus, 172
- Scombridae
 - Scomber scombrus, 107
- Scophthalmidae
 - Scophthalmus aquosus, 141
- Scophthalmus aquosus, 141
- Sea lamprey, 133
- Sea raven, 73
- Sea tadpole, 158
- Sebastes, 43
- Sebastidae
 - Helicolenus dactylopterus, 110
 - Sebastes, 43
- Shorthorn sculpin, 147
- Shortnose greeneye, 144
- Sigouine de roche, 163
- Silver hake, 37
- Silvery John dory, 170
- Silvery lightfish, 145
- Slender snipe eel, 160
- Smooth skate, 88
- Snakeblenny, 118
- Spatulate sculpin, 150
- Spotfin dragonet, 167
- Spotted wolffish, 136
- Spottedfin tonguefish, 175
- Squalidae
 - Squalus acanthias, 94
- Squalus acanthias, 94
- Sternopychidae, 173
 - Maurolicus muelleri, 145
- Sternopychidae, 173
- Stichaeidae
 - Eumesogrammus praecisus, 165
- Leptoclinus maculatus, 119
- Lumpenus lampretaeformis, 118
- Ulvaria subbifurcata, 164
- Stomias boa, 146
- Stomiidae
 - Stomias boa, 146
- Stromateidae
 - Peprilus triacanthus, 121
- Stromaté fossette, 121
- Syphurus diomedeanus, 175
- Sébaste chèvre, 110
- Sébastes de l'Atlantique, 43
- Tanche-tautogue, 139
- Tautogolabrus adspersus, 139
- Terrassier tacheté, 166
- Thorny skate, 85
- Tourteau jona, 126
- Tourteau poïnclos, 127
- Trachyrincus murrayi, 153
- Triglops murrayi, 70
- Turbot de sable, 141
- Ulcina olrikii, 151
- Ulvaire deux-lignes, 164
- Ulvaria subbifurcata, 164
- Urophycis chuss, 34
- Urophycis tenuis, 31
- Vahl's eelpout, 120
- Variegated snailfish, 157
- White barracudina, 171
- White hake, 31
- Windowpane flounder, 141
- Winter flounder, 58
- Winter skate, 91
- Witch flounder, 52
- Wolf eelpout, 159
- Wrymouth, 166
- Yellowtail flounder, 55
- Zeidae
 - Zenopsis conchifer, 170
- Zenopsis conchifer, 170
- Zoarces americanus, 82
- Zoarcidae
 - Lycenchelys verrillii, 159

Lycodes lavalaei, 162
Lycodes reticulatus, 168
Lycodes terraenovae, 161
Lycodes vahlii, 120
Melanostigma atlanticum, 169
Zoarces americanus, 82

Éperlan arc-en-ciel, 138
Éperlan du large, 144